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THE

DRIGGS-SCHROEDER SYSTEM

OF

RAPID-FIRE GUNS.

AMERICAN ORDNANCE COMPANY.

702 SEVENTEENTH STREET, WASHINGTON.
315 BROADWAY, NEW YORK.

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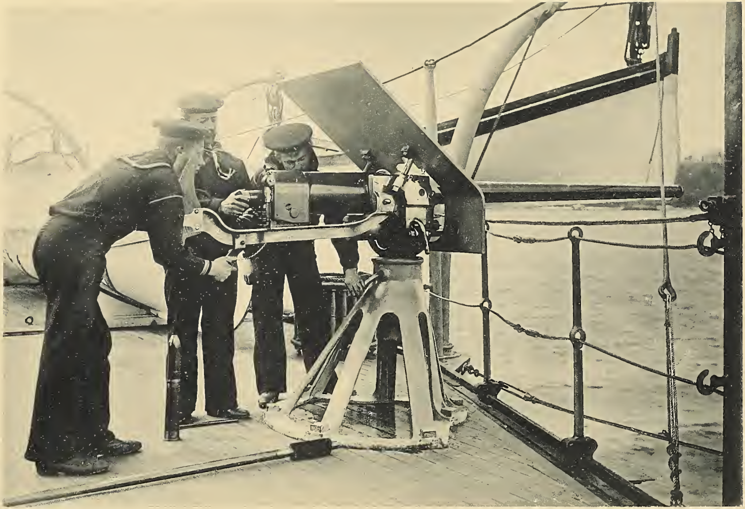

6-POUNDER DRIGGS-SCHROEDER GUN, U. S. S. COLUMBIA.

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THE
DRIGGS-SCHROEDER SYSTEM
OF
RAPID-FIRE GUNS.

GUNS, MOUNTS, AMMUNITION.

WITH ILLUSTRATIONS.

AMERICAN ORDNANCE COMPANY.

OFFICES:
702 SEVENTEENTH STREET, WASHINGTON.
315 BROADWAY, NEW YORK.
TELEGRAPHIC ADDRESS: ORDNANCE.

SHOPS:
GUN FACTORY: BRIDGEPORT, CONN.
PROJECTILE FACTORY: LYNN, MASS.
TORPEDO STATION: TIVERTON, R. I.

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PREFACE TO SECOND EDITION.

Since the issue of the first edition of this book, the unremitting attention devoted to the simplification of details and to the maintenance of a high standard of work has resulted in a continued improvement in the tactical and mechanical features of Driggs-Schroeder guns. The system has maintained a clear record in the matter of casualties and accidents. In routine drills and target practice, and during very severe proving ground trials, no one has ever been injured in the service of these guns, and no mishaps have occurred except such trivial ones as may occasionally result, for instance, from a firing point being too brittle in consequence of too high tempering, etc.

In this edition copious quotations will be found from the reports on the various trials, competitive and other, to which the system has been subjected on the government proving grounds in the United States, and no better certificate of superiority can be desired than a complete publication of all such reports *in extenso*. As will be noted under the proper caption, the Driggs-Schroeder 4-inch gun was the only one of that approximate caliber which was able to complete the programme laid down for the comparative trial held at Sandy Hook in 1895, and it was furthermore unhesitatingly pronounced by the Board to be "a simple, safe and efficient mechanism for a rapid-fire gun of this caliber."

Several changes made in the details of the breech mechanism, in the interest of simplicity and reduction of parts, have been combined to form the Mark II, which is at present the standard mechanism of the system for all calibers. In the 6-pounder the higher-powered design called the Mark II in the first edition is now termed the Mark III, the mechanism being of the Mark II type, but the gun and the powder charge being heavier.

The 12-pounder Field and Landing gun has passed beyond the experimental stage; and its carriage, evolved through much experiment at the Company's proving ground, has added greatly to its military efficiency.

The American Ordnance Company has acquired all United States patents for the Accles Machine Gun, and all manufacturing and selling rights for North, Central and South America. This weapon was the only one of five competitors in a trial before the U. S. Navy Department in December, 1895, which was able to complete the programme of the trial. A brief notice of it will be found at the end of this volume.

PREFACE TO FIRST EDITION.

The salient feature in recent gun development has been the perfection and extension of the Rapid-fire principle.

With the creation of fleets of fast torpedo-boats there quickly came a recognition of the fact that the only defense against their attack lay in a great volume of fire; this could only be obtained to an adequate degree by multiplying the number of small guns on board ship, and by endowing each gun with great rapidity of fire, mobility and accuracy. A solution of the first part of this problem was found to lie in the adoption of metallic case ammunition, and of a breech-operating mechanism capable of reducing to a minimum the time required to eject, cock and load. Mobility was obtained by using a central-pivot, non-recoil mount, on which the gun could be freely trained through any arc, lateral or vertical, such train being effected by the firer personally, a shoulder-rest or stock enabling him to transmit the movements of his body to the piece. Accuracy requires a flat trajectory, fine sights (within rational limits,) and the ability of the firer to steady himself with the stock while using the latter to point the gun.

Mechanical gun-fire did not meet with the success that was expected, for several reasons, prominent among which may be cited the derangement of aim caused by the application of power to the operating crank; the single-barrel, hand-loading gun has survived for calibers capable of shell-fire.

Such are the broad features of the rapid-fire gun of to-day, though modifications have been introduced into many details.

It has been found expedient and feasible to use mounts which allow a slight recoil in the line of fire, with automatic return to battery, the stock being attached to the non-moving part of the mount, so as to still retain that important factor of mobility and accuracy. The best and general practice now is to allow a limited recoil to even the smallest calibers, and much mechanical skill has been displayed in producing various types of such recoil mounts.

The most prolific field, however, has been that of fermetures, and a number of systems have sprung into existence, being original inventions, or modifications or patent-dodging copies of those previously produced. Some are ingenious; many are comparatively clumsy.

The power otherwise wasted in the recoil and counter-recoil may be advantageously used to assist in some of the operations of the service of the gun, that which seems to interfere the least with other functions or tactical considerations being the automatic opening, ejecting and cocking by the counter-recoil. The difference in the rates of fire of aimed and unaimed shots is simply the time occupied in pointing, and the only operations in which the rates of fire of different systems may usually be compared are those of extracting and loading. It is therefore evident that an instantaneous automatic ejection followed by the manipulation of a light, easily moving, sheltered block will produce the most efficient results in active service, even more markedly than on the proving ground. The danger of wasting ammunition does not enter here as it does with automatic or hand-worked machine guns, for each shot is fired individually by pressing on the detent when the sights are on, and the case does not occur of a number of shots being fired after the firer has made up his mind to stop, or while he is trying to rectify his aim.

For some years the rapid-fire principle was applied only to guns throwing projectiles weighing six pounds or less, and their one great sphere appeared to be that of repelling the attack of torpedo-boats. But as their powers increased and the quality of ammunition improved, their existence compelled such modification of details as to influence the design of ships; shields had to be provided for the guns' crews, and these finally led to such an amount of thin armor as to seriously modify the perplexing question of weights and displacement. Recently the system has been expanded to embrace calibers up to six-inch, and rapid-fire guns up to that size will undoubtedly soon constitute wholly the main batteries of unarmored vessels and the auxiliary batteries in battle-ships. It is even anticipated that a breech-closure adapted to metallic case ammunition will be eventually applied to guns of eight and ten-inch caliber, the advantages gained lying in non-necessity of sponging, the use of the best known obturation, and the simplification of firing attachments.

For sea-coast works and the defense of mine-fields, booms, &c., rapid-fire batteries are essential. The length of approach and extent of ground to be swept naturally differ with the locality, but, as a rule, a greater range is imposed than in the defense of ships. Giving due weight to the conflicting requisites of power, mobility, rapidity of fire, and maximum efficient aiming range, a high-powered

9-pounder, with automatic ejection, seems to present the most useful compromise for mine or boom defense.

For field guns, the use of metallic case ammunition possesses many attractive features, but it is worthy of note that in the United States no attempt was made to experiment in this line until the Driggs-Schroder breech-closing system had been produced, which by its lightness and its immunity from injury commended itself so strongly for the purpose. The problem of ammunition supply cannot keep metallic cartridges out of the field, but it will certainly compel the maintenance of a high standard of quality in the cartridge cases, by requiring that they shall be capable of a considerable amount of firing without the necessity of reforming.

CHAPTER I.

ESSENTIAL QUALITIES OF RAPID-FIRE GUNS. CHARACTERISTICS OF THE DRIGGS-SCHROEDER SYSTEM, AND ANALYSIS OF THE QUALITIES INHERENT IN IT.

✓

There are six qualities which are essential to an efficient rapid-fire gun. These are:

1. Safety.
2. Ease and rapidity of working the breech mechanism.
3. Ease, rapidity and accuracy of pointing.
4. Velocity of projectile.
5. Certainty and force of extraction.
6. Protection of the mechanism.

Characteristics of the Driggs-Schroeder System.

The action of the Driggs-Schroeder breech mechanism is a distinct departure from that of any pre-existing system. The motion of the block, which is in a single piece, is at first downward to disengage it from its support, and then rotary to the rear. The very small amount of vertical motion reduces to a minimum the dimensions and weight of the block, while also its revolution on an interior axis makes its manipulation all the more easy. The support is effected by bands upon the top and sides of the block which engage in grooves in the interior of the breech.

The principal features which spring from this general design are: there is no opening necessary in the top of the breech through which rain or dirt can enter; with the breech open as well as with it closed, the block and entire mechanism remain within the curtain and are completely protected; the lightness of the block promotes rapidity of fire, and, together with the equally unique lightness of the housing, affords a margin of total weight which permits of a length of bore and resultant power, and a thickness of walls, greater than those of other systems of the same weight. The gain in power, being due to the increased travel of shot, is not accompanied by any sensible increase in the violence of recoil. The cross-sections which are increased are those of the chase, so that a slower powder may be used, thus increasing still further the muzzle velocity.

Incidental to these leading characteristics are the existence of double, independent extractors, the ability to half-cock if desired, and the easy application of a device for automatically ejecting the empty cartridge case.

An examination will now be made of the qualities mentioned above as being essential, and it will be seen that the Driggs-Schroeder guns owe their success on the proving ground and in service to the fact that they possess those qualities to an unusual degree.

Safety of Gun Body.

The study of the safety of a system leads to an examination of the safety dependent upon the strength of the gun body, and of that dependent upon the strength and peculiar features of the mechanism.

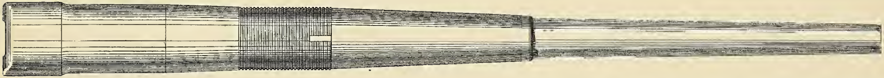
The former is affected by the mode of construction and the quality of the metal used. In designing the Driggs-Schroeder guns full consideration is given to the varying conditions under which rapid-fire guns are used, and the severe treatment to which they are often subjected. In recognition of the fact that they may sometimes have unusual strains put upon them through the use of different powders or of powders that may have deteriorated, slight variations in the size and weight of projectiles, etc., they are designed to sustain pressures far in excess of the normal ones; and the construction is such that owing to the proper proportioning of parts, and to improved methods of shrinking, the strength is the greatest that can be attained with any given strength and weight of metal.

The high-power guns are built-up, and consist of a tube, jacket, and hoop. The breech-block engages in the jacket. The general construction of the gun body is shown on Plate I, and the parts are assembled in the following manner:

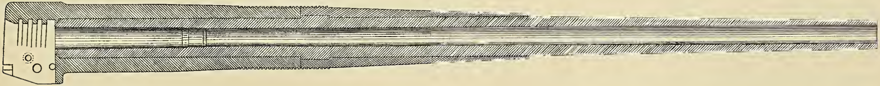
The hoop, the first piece to be shrunk on the tube, is expanded by heat and slipped on from the muzzle end until the shoulder on its interior is close against a corresponding shoulder on the tube; and it is firmly held in this position until cold. The jacket is then put on in like manner from the breech end. This method insures perfect contact at the shoulders between the tube and hoop. On the exterior of the gun is cut a screw-thread, part of which is on the hoop and part on the jacket, and on this is screwed the trunnion-band for non-recoil mounting, or sleeve for recoil mounting, thus locking the entire system and preventing any longitudinal motion between tube and jacket or hoop.

CONSTRUCTION OF DRIGGS-SCHROEDER 6-POUNDER, MARK III.

PROFILE.



LONGITUDINAL SECTION.



The strength and the shrinkages used are expressed in the following equations, the shrinkages being computed for each gun according to the characteristics of the metal:

$$P_1 = \frac{3\theta_1(R_2^2 - R_1^2)}{4R_2^2 + 2R_1^2}$$

$$\left.\begin{aligned} P_0^{(1)} &= \frac{3\theta_0(R_1^2 - R_0^2) + 6R_1^2 P_1}{4R_1^2 + 2R_0^2} \\ P_0^{(2)} &= \frac{3\rho_0(R_1^2 - R_0^2) + 2R_1^2 P_1}{4R_1^2 - 2R_0^2} \end{aligned}\right\} \begin{array}{l}\text{using the one that} \\ \text{gives the less value.}\end{array}$$

$$\varphi_1 = \frac{1}{E}\left[\frac{(4R_0^2 + 2R_1^2)P_1 - 6R_0^2 P_0}{3(R_1^2 - R_0^2)} + \theta_1\right]$$

$$S_1 = \varphi_1 \times D_1.$$

These formulæ are deduced from those in Notes on the Construction of Ordnance, No. 35, by Captain Rogers Birnie, Jr., U. S. A.; the shrinkages being in terms of the pressures in a state of action, and on the hypothesis that the modulus of elasticity, E, is constant and equal to 29,000,000 pounds. The elastic strength of compression is assumed to be equal to the elastic strength of tension. The factor of safety is known to be very large.

To guard against the adoption of a shrinkage which would cause permanent compression of the bore, the variations of pressure in the states of rest and of action are computed by the formula:

$$p_1 = -\frac{R_0^2(R_2^2 - R_1^2)}{R_1^2(R_2^2 - R_0^2)} P_0,$$

and the resisting power of the tube by the formula:

$$P_1^{(1)} = \frac{R_1^2 - R_0^2}{2R_1^2} \theta_0 .$$

In every case $P_1 + p_1 < P_1^{(1)}$.

In the above, ρ_0 represents the elastic strength of compression of the metal of the tube, and θ_0 and θ_1 that of tension of tube and jacket respectively.

The tube and jacket are proportioned, as nearly as possible, so that the exterior radius of the tube will be a mean proportional between the interior of the tube and exterior of the jacket, that being theoretically the strongest construction.

As a farther check upon the safety and admissibility of the skrinkages adopted, a special examination has been made of the powder chamber section of the 6-pounder. This study included a computation of the displacements caused by the shrinkages and due to the resulting pressures in the states of rest and of action, and a comparison of these displacements with the safe limits to which the metal may be extended or compressed at the four surfaces of tube and jacket.

The anticipated displacements are expressed in the following equations:

	State of Rest.	State of Action.
Interior of Tube $\frac{\Delta R_0}{R_0} =$	$- \frac{2R_1^2}{(R_1^2 - R_0^2)E} P_1^1$	$\frac{(4R_1^2 + 2R_0^2)P_0 - 6R_1^2}{3(R_1^2 - R_0^2)E} P_1$
Exterior of Tube $\frac{\Delta R_1}{R_1} =$	$- \frac{4R_0^2 + 2R_1^2}{3(R_1^2 - R_0^2)E} P_1^1$	$\frac{6R_0^2 P_0 - (4R_0^2 - 2R_1^2)}{3(R_1^2 - R_0)E} P_1$
Interior of Jacket $\frac{\Delta R^1}{R_1} =$	$+ \frac{4R_2^2 + 2R_1^2}{3(R_2^2 - R_1^2)E} P_1^1$	$+ \frac{4R_2^2 + 2R_1^2}{3(R_2^2 - R_1^2)E} P_1$
Exterior of Jacket $\frac{\Delta R_2}{R_2} =$	$+ \frac{2R_1^2}{(R_2^2 - R_1^2)E} P_1^1$	$+ \frac{2R_1^2}{(R_2^2 - R_1^2).E} P_1$

The safe limits for the displacements are given by the formulæ:

Interior of Tube $\frac{\theta_0 = \rho_0}{E}$

Exterior of Tube $\frac{\theta_0 = \rho_0}{E}$

Interior of Jacket $\frac{\theta_1}{E}$

Exterior of Jacket $\frac{\theta_1}{E}$

All these are relative values, and must be multiplied by the corresponding diameters to get the absolute displacements.

The *plus* sign indicates extension. The *minus* sign indicates compression.

Three extreme cases were considered, under the most unfavorable conditions that can arise, namely:

1st. Weak Tube and strong Jacket: for which

$\theta_0 = \rho_0 = 45{,}000$ lbs. per sq. inch
$\theta_1 \quad = 65{,}000$ " "

2nd. Strong Tube and weak Jacket: for which

$\theta_0 = \rho_0 = 65{,}000$ lbs. per sq. inch
$\theta_1 \quad = 45{,}000$ " "

3rd. Weak Tube and weak Jacket: for which

$\theta_0 = \rho_0 = 45{,}000$ lbs. per sq. inch
$\theta_1 \quad = 45{,}000$ " "

The values resulting from a substitution of assigned values for the elastic qualities are given in the accompanying table.

In the first column will be found the elastic limits assumed for the metals in the two layers, together with the resulting strength and skrinkage.

Column (2) gives the surfaces for which the displacements are figured.

Column (3) gives the anticipated displacements that take place due to the pressure between contact surfaces, considering that there is no interior pressure, *i. e.*, for the system at rest.

Column (4) gives the anticipated displacements due to the interior pressure and pressure at contact surface both acting, *i. e.*, when the system is in a state of action.

Column (5) gives the safe limits for displacements.

Table showing the Displacements anticipated in the 6-pounder Driggs-Schroeder Gun both in Action and at Rest, and the Anticipated Safe Limits for the Displacements based on the Elastic Qualities of the Metal.

POWDER CHAMBER SECTION.

Elastic Limits. Strength and Shrinkage.	Surface Considered.	State of Rest.	State of Action	Safe Limits.	Differences.		Pressures. Tons per sq. Inch.	
					Rest.	Action.		
(1)	(2)	(3) Inches.	(4) Inches.	(5) Inches.	(6) Inches.	(7) Inches.	(8)	
Tube = 45,000 lbs	Interior of Tube	−0.00396	+0.00219	±0.00421	0.00025	0.00202	Action.	$P_1 = 10.009$
Jacket = 65,000 lbs.	Exterior of Tube	−0.00398	−0.00047	±0.00853	0.00455	0.00806		$P_0 = 18.681$
Strength = 41,846 lbs	Interior of Jacket	+0.00882	+0.01233	±0.01233	0.00351	0.00000	Rest.	$P_1^1 = 7.1616$
Shrinkage = 0″.0128	Exterior of Jacket	+0 00719	+0.01005	±0.01860	0.01141	0.00855		
Tube = 65,000 lbs.	Interior of Tube	−0.00192	+0.00205	±0.00607	0.00415	0.00402	Action.	$P_1 = 6.9295$
Jacket = 45,000 lbs.	Exterior of Tube	−0.00193	+0.00042	±0.01233	0.01040	0.01191		$P_0 = 22.6995$
Strength = 50,848 lbs	Interior of Jacket	+0.00427	+0.00853	±0.00853	0.00436	0.00000	Rest.	$P_1^1 = 3.4695$
Shrinkage = 0″.0062	Exterior of Jacket	+0.00348	+0.00696	±0.01288	0.00940	0.00592		
Tube = 45,000 lbs	Interior of Tube	−0.00240	+0.00317	±0.00421	0.00181	0.00104	Action.	$P_1 = 6.9295$
Jacket = 45,000 lbs.	Exterior of Tube	−0.00242	+0.00075	±0.00853	0.00611	0.00778		$P_0 = 16.9285$
Strength = 37,920 lbs.	Interior of Jacket	+0.00536	+0.00853	±0.00853	0.00371	0.00000	Rest.	$P_1^1 = 4.3493$
Shrinkage = 0″.0078	Exterior of Jacket	+0.00437	+0.00696	±0.01288	0.00851	0.00592		

NOTE.—The *plus* signs indicate extensions; the *minus* signs indicate contractions.

$$\left.\begin{array}{l} D = 2.71 \\ D_1 = .55 \\ D_2 = 8.3 \end{array}\right\} \text{Diameters of sections.}$$

Columns (6) and (7) give the differences between the anticipated displacements and the anticipated safe limits, *i. e.*, the residual elastic stretch of the metal.

It will be noticed that in every case the limit is equal to or greater than the anticipated displacement, showing that the shrinkage is perfectly safe and admissible.

Column (8) gives the values of the pressures in tons per square inch that may be brought to bear on the system both in action and at rest, with entire safety. In this connection it should be noted that in practice, as will be seen farther on, no metal is used of an elastic strength so low as 45,000 pounds; also, no comparatively weak tube is ever associated with a similarly weak jacket.

In determining gun profiles, careful study has been given to the subject of slow-burning powders, the adoption of which modifies the pressures; while the maximum pressure is less, it is sustained for a much greater distance along the bore. To provide for this the strength at the bottom of the chamber is made equal to what was necessary with quicker powders, but from the front end of the hoop to the muzzle it has been much increased. A more complete combustion is also attained by making the bore longer than has been done before, the weight of the resulting gun being no greater than that of the shorter and weaker guns of rival systems, owing to the lightness of the Driggs-Schroeder breech-block and housing.

The metal used in the United States is the best quality of open hearth steel furnished by the Midvale Steel Company and the Bethlehem Iron Company. A test piece two inches long by one-half inch diameter is cut from each end of every forging, which, when broken, must show the steel to possess the following characteristics:

Elastic strength, not less than 50,000 pounds per sq. inch.

Elongation, after rupture, not less than 17 per cent. of its length.

Contraction, not less than 20 per cent. of its original area.

For breech-blocks the specifications are still higher, an elastic strength of not less than 70,000 pounds per square inch being required.

If the figures of any piece fall below the above, the forging is rejected. The tensile strength obtained is usually between 90,000 and 130,000 pounds per square inch.

These forgings are oil-tempered and annealed, the last process being always an annealing one, to relieve any internal strains in the metal. The test pieces are cut after the last process.

Safety of Breech Mechanism.

The safety of a breech-mechanism depends upon its resistance to *déculassement*, and its freedom from danger of premature discharge, blowing out of firing pin, or other accident. In regard to the first, in the Driggs-Schroeder guns the thrust is transmitted to the jacket by bands upon the upper part and sides of the breech-block. This method of securing the block not only renders possible the great reduction of weight effected, but also retains the one chief advantage of the interrupted screw-plug, viz., that of distributing the stress over a large superficial area.

With regard to premature discharge, the official report made in 1888 on the first 3-pounder says: "Experiments were made to determine whether the cap could be snapped and the gun fired before the breech was fully closed. There was found to be no possibility of such an accident, the arm of the cocking cam being always interposed to prevent the firing pin from striking the cap until the breech is locked." This has been fully borne out since that time by experience in service and during competitive trials with other guns on various proving grounds. At the trial of a 4-inch in 1895, an unusually delicate operation was ordered; a case was put in the gun, in which the cup containing the primer had been left projecting $\frac{1}{32}$ of an inch beyond the head of the case, and the block closed quickly; upon opening the breech again and removing the case it was found that the block had simply forced the cup containing the primer to its proper seat in the head of the case.

As a corollary to the above, in opening the breech the firing pin is always retracted to within the limits of the block before the latter can descend, so that it is impossible that the point should be broken or bent.

A glance at the firing pin, or at a drawing of it, will make it clear how the cocking arm and the upturned head would both have to be sheared before it could be projected to the rear.

A distinctive feature of the Driggs-Schroeder system is the ability to cock the piece without opening the breech. Apart from being occasionally a great convenience, this is a notable element of safety and of saving of time in the event of an apparent misfire; should the apparent misfire be a hangfire, a serious accident might occur from the ignition of the cartridge after starting the block from its seat in systems in which the cocking can only be accomplished by the motion of the handle. Incidental to this is the ability to half-cock, if it should have been considered desirable to fashion a half-cock stud or notch on the firing pin; the report quoted above on the 3-pounder, says of this: "It is a feature of this system, which gives it an advantage over certain others, that the firing pin may be set and kept at half-cock. Tested in this position it is found to be free from danger of accident."

A simple device upon the operating lever holds the block securely in position when closed. The report on a 6-pounder subjected to a 200-round endurance test at Annapolis says: "The new locking device answers its purpose well. No liability of its being jarred or knocked open while firing was noticed."

The rectilinear motion of the Driggs-Schroeder firing pin causes it to strike the cap fairly in line with its motion, so that no bending strain is brought upon the striker point, as is the case in systems where the firing pin or hammer has a circular motion. Such a bending strain sometimes breaks the point of the hammer and leaves it embedded in the cap, and as the block cannot move until the point is withdrawn, this accident becomes a serious one. Furthermore, the rectilinear motion admits of a much smaller point, which in turn requires but a small hole in the face-plate, and thereby greatly increases the support of the cap and decreases the chance of escape of gas into the mechanism.

The power of the system to resist the effects of defective ammunition has been well tested. For this purpose at a trial in England in 1891, eight split cases and three pierced primers were the results out of twenty rounds, constituting probably the most severe test a gun of this class had been put to up to that time; the piece worked perfectly throughout with the exception of one misfire which occurred after one of the blow-backs, and this cap was immediately exploded by snapping a second time after recocking. Still more severe tests have been applied in the United States, notably at the Sandy Hook proving ground in May, 1894, during a competitive trial of 6-pounders. On this occasion defective cartridges prepared in three ways were used; first by filing obliquely at four equidistant points through the edge of the rim so as to show an opening to the interior at the junction of the breech and the wall; second, by sawing two slots through the head so as to show openings to the interior; third, by thinning the metal of three primers so as to cause blow-backs. In applying the last method all three primers were blown out, and in all the experiments a great quantity of gas escaped into the mechanism and fouled it; but no injury was done beyond what was remedied by washing.

The mutual support of parts and relation of bearing surfaces in the Driggs-Schroeder system were well shown in a unique test applied to the main bolt of the 4-inch gun tried at Sandy Hook in 1895. The official report was as follows: "As some doubt existed as to whether, under normal conditions, any portion of the pressure on the block could be transmitted to the main bolt, the latter was replaced by a wooden bolt of the same dimensions. The bearing surfaces on the block and jacket were well cleaned and dried, in order to utilize as much friction as possible. Two rounds were then fired with half and full charges respectively; the bearing surfaces were then thoroughly lubricated to diminish friction, and the two rounds were repeated—the wooden bolt was uninjured." The wood used was white pine.

Ease and Rapidity of Working the Breech Mechanism.

Rapidity of fire, and especially of sustained fire, is influenced most directly by the weight and mobility of the breech-block. As has been previously mentioned as one of the characteristics of the Driggs-Schroeder system, the block is remarkably light; the weight of the entire breech-mechanism as stated in the report of the 1894 trial, is 35¼ pounds, as compared with 64¾ and 77½ pounds respectively for its two principal competitors. Also, owing to the fact that almost all of the motion is rotary on an interior axis, the full weight has to be lifted for only a very small portion of its action, six-tenths of an inch in the 6-pounder and one inch in the 100-pounder. During the entire rotary portion of the motion the block moves in unison with the handle, thus giving it a greater rapidity of movement than that of blocks in which the movement is retarded by the interposition of a lever.

The practical result of this is that for calibers up to and including the 14-pounder, the breech is opened and closed with perfect ease by the left hand, and it is found that the best service is obtained by having the operating handle on the left side, and having the cartridge inserted by the same man who closes the breech. In this way two men are all that can be effectively employed in working the piece, thus permitting a reduction in the crews of vessels of one man for every rapid-fire gun of the secondary battery.

In loading, it is not necessary to put the rim of the cartridge close to the extractors; in the 6-pounder it may be placed three-quarters of an inch from them, and in the 4-inch, 3½ inches. This is of advantage, not only in the saving of time, but also in the elimination of the danger of jamming the cartridge by raising the block against it before it is so placed as to enter the chamber.

In the 1894 trial of 6-pounders, the number of rounds reported as fired in one minute was 32, the crew consisting of two officers to work the piece and one enlisted man to hand the ammunition to the loader. Of all the other five guns competing, the next greatest number fired was 28, with a crew of four. In the 5-second trials the same report gives the number fired as follows:—"Driggs-Schroeder, at the first trial, 3; at the second trial, 3; at the third trial, 3, with one left in the chamber." None of the other guns present had a record of 3 in each trial.

The facility of working was farther illustrated during the same trial by a dry test. The mechanism was washed with soap and water and then dried in the sun, after which it was re-assembled, and an attempt was made to work it without using oil. The Driggs-Schroeder worked with perfect ease, while none of the rivals could work without difficulty, and three could not be operated at all.

Ease, Rapidity, and Accuracy of Pointing.

In the Driggs-Schroeder guns for secondary batteries, the stock is on the right side; the pointing is, therefore, done from the right shoulder, which is the natural and usual position taken in the use of firearms.

Rapidity of pointing is further promoted by the fact that the man who loads and works the breech mechanism is on the left of the gun, leaving the line of sight and field of vision perfectly clear on the right side, so that the aim can be kept between shots while loading.

It has also been found in practice that in rapid firing, especially at a moving target, when it is necessary to keep the gun on the target as nearly as possible during the operation of loading, the accuracy of fire is affected favorably, as compared with rival systems, by the absence of great effort to close the breech. At an official trial of 6-pounders, in 1893, the report stated "owing to the little effort required to close the Driggs block, the derangement of the aim is less than with the [Rival gun]."

Velocity of Projectile.

The saving of weight effected in the Driggs-Schroeder breech-closure permits a lengthening of the bore and a strengthening of the chase without any increase in total weight as compared with guns of the same calibers of other systems. As a result of this a higher muzzle velocity is obtained.

It has been argued that the same results could be reached by slightly increasing the weight of the other guns. But the necessary increase cannot properly be called slight. The report on the Indian Head trial of 1893 states:—"For the purpose of comparing the effect of the type of breech-mechanism upon the weight of the after portion of the gun, the weight of that part in rear of a section six inches forward of the face of the tube and its ratio to the total weight of the gun were computed, the block and mechanism being in place. The result was found to be for the [Rival gun] thirty-six per cent., and for the Driggs-Schroeder twenty-five per cent." This difference of 11 per cent. represents a weight of 86 pounds which is utilized to lengthen the chase, and also to strengthen it, thus admitting of the use of slower and more progressive powders.

The present standard 6-pounder Driggs-Schroeder (Mark II) has a 50-caliber bore, giving a mean velocity, with black cubical powder, of 1891 f. s. at 125 feet from the muzzle, the total weight of the gun being 786 pounds; while the weight of its principal competitor was 792 pounds, and its mean velocity 1812 f. s., with the same loading. These figures are quoted from the official report of the 1894 trial.

Certainty and Force of Extraction.

The Driggs-Schroeder gun has two independent extractors, either of which will eject the empty case. The strain is divided on both sides of the cartridge head, so that if one side of the rim should be weak or should part, the case would be safely ejected by the other extractor; or if by any accident one extractor should become disabled, the gun could still continue to fire, while the guns of other systems having but one extractor are disabled by its breaking. At the end of the 1894 trial, in which 451 shots were fired, including some with excessive pressures, and others for dust and rust tests, etc., the extractors were still in perfect condition.

No extraction is really efficient if not accompanied by *ejection*. The cam surface which operates the Driggs-Schroeder extractors is of such shape as to impart at first a slow and very powerful motion, by which the cartridge case, expanded, as it is, against the walls of the chamber by the heat and pressure of the discharge, is loosened and gently started to the rear. The motion then becomes gradually more rapid, until, when the breech is entirely open, the case is flung out well clear.

In case of a cartridge case sticking so that it cannot be extracted, it is always possible to remove the Driggs-Schroeder block and ram the case out from the muzzle. This important feature was tried and reported in the naval trial of 1893.

Protection of the Mechanism.

The Driggs-Schroeder system is unique in that the entire mechanism necessary to work the gun (excepting the operating handle) is protected at all times by the hood of the breech. When a pistol-grip is used in place of a lanyard, the trigger under it is outside, but this, though a convenience, is not essential to the working of the gun, as it can be fired by pressing down the sear on the rear face of the block. In the latest models the pistol-grip is placed on the shoulder-bar, or else a pear-shaped handle is attached to the end of the lanyard and the firing effected by a direct pull downward, thus doing away with that one exposed part.

In other systems in which the breech-block is swung off to the side in opening, it is exposed in that position to the enemy's fire; and in those having the housing for the mechanism open at the top, falling fragments are apt to lodge there, rain and spray beat in, and on shore sand and dust will collect in the mechanism.

In the 1894 trial at Sandy Hook, the guns were subjected to a severe dust test as follows. The breeches were subjected to a blast of dust for eight minutes, burnt sand from the butts being used, well dried. After being thus dusted each gun was remounted and the time was noted to open the breech and fire five rounds. The report states that in the test of the Driggs-Schroeder gun "The block was opened without difficulty by one man, and the five rounds were fired with very little trouble. The bore was not wiped out. No oil or water was used on the block. Time to open block and fire five rounds, 55½ seconds." The time required to do the same with the most prominent competitor was stated in the same report to be 22 m., 47 sec.

In guns for field or landing service, where dust and sand are encountered, this matter is one of the greatest importance. For guns afloat, the verdict of such practical men as the gun-captains in the Navy has been that the Driggs-Schroeder breech-mechanism is preferable to others on the score of being less liable to rust, and of being more accessible and easier to clean.

Applicability to Large Calibers.

The advantage of a light breech-block becomes greatly accentuated in heavy calibers, and constitutes a strong argument for the adoption of the Driggs-Schroeder system in the main batteries of naval vessels or auxiliary cruisers. The actual weight of the block of the 4-inch (33-pounder,) including all parts to be lifted, is 74 pounds, and this has only to be raised vertically one inch. In an eight-inch gun the lift is also only one inch; while a heavy vertically moving block would have to be raised and lowered 12 or 13 inches.

The sliding block being so unwieldy, recourse has been had to various devices for adapting the screw plug to the use of metallic cartridge cases; but this method, while superior to the sliding block, is open to objections. The main features of all this class are much the same; the working parts are almost all exterior to the gun and exposed to accidents, and while in the loading position, project to one side and are unprotected.

The Board which conducted the trial of the 4-inch gun at Sandy Hook in 1895, after reciting the various points of excellence of the Driggs-Schroeder system as detailed in the preceding pages for smaller calibers, added the following regarding it: "The position of the man who aims and fires the gun, as well as of the one who manipulates the block, is on the side of the gun well forward of the breech. No portion of the body of the man working at the block is, at any time during the firing, required to be in rear of the gun. This is considered by the Board a very important and valuable feature, as under other conditions it might easily happen in the excitement of rapid firing, that the piece would be fired at the instant the breech was closed, and before the man at the block could get out of the way. The effect of the recoil under these circumstances would be serious if not fatal." The importance of this was illustrated by the accidents which occurred to two rival guns during this trial, a *déculassement* in one case and premature discharge in the other.

The final conclusion of the Board was as follows: "As a result of this test the Board is of the opinion that the 4-inch Driggs-Schroeder has shown itself to be a simple, safe and efficient mechanism for a rapid-fire gun of this caliber."

The claim of the superior adaptation of the Driggs-Schroeder system to large calibers is corroborated by the following extract from the report of the trial of other guns at the same time as the above: "As stated in the last annual report, four rapid-fire guns of 4.724-inch (12 centimeters) caliber, of foreign manufacture, were procured under allotments of the Board, viz: The [Rival A], [Rival B], [Rival C] and [Rival D]. The tests of these guns have proceeded at the proving ground during the year, but none of them have succeeded in concluding the programme prescribed for this class of guns. The breech of the [Rival C] was blown off at an early stage of the test, the breech-block of the [Rival B] was blown out by a premature explosion, and the mechanisms of both the [Rival A] and [Rival D] have been disabled by firing."

Summary of Special Advantages.

From the preceding, the special advantages of the Driggs-Schroeder system may be summarized as follows:

Perfect safety and reliability.

The gun may be cocked at will without opening the breech.

The gun may be adapted to half-cock if desired.

The unusual lightness of the block conduces to a greater rapidity of fire than in other systems, as shown in the various trials: Combined with the lightness of the housing, it also permits a greater strength and length of bore for the same weight, which results in greater muzzle velocity and striking energy.

As the block revolves, its manipulation is the more easy, a factor of importance in sustained fire.

Only two men are required for the actual crew of a secondary battery gun.

The entire mechanism is at all times completely enclosed by the hood of the breech, and thus protected from the enemy's fire, from accident, and from rain or dust.

The stock comes to the right shoulder, which is the natural position in firing.

The loading is done on the opposite side of the gun from the sights, leaving a clear field of view for the gun-captain; and the motion of the block in loading is such as not to derange the aim.

The lightness of the block conduces especially to successful application to large guns.

CHAPTER II.

PARTICULARS OF THE BREECH MECHANISM. DIRECTIONS FOR DISMOUNTING AND ASSEMBLING. AUTOMATIC EJECTION. RIFLING.

The action of the Driggs-Schroeder breech-mechanism is very simple; it contains no delicate parts and is not easy to get out of order. The fact of the block and all the working parts being symmetrical also makes it easy to understand from the drawings.

Description of the Mechanism.

The mechanism has been considerably simplified in the last year or two, and now consists of 12 moving, or tactical, pieces. These are as follows: Breech-block, main bolt, firing pin, firing spring, cam, face-plate, sear, sear-spring, operating handle, handle-locking spring, and two extractors. The principal changes in the mechanism of the block itself have been the substitution of the new sear-spring in place of the coiled spring and retaining lug, and making the enlarged front end of the present sear-spring do the duty of the former face-plate retaining screw; the projecting arm has been omitted from the sear, and these changes consequently abolish also the lock-shaft, pistol-grip, trigger and screws. An eye formed in the rear end of the firing pin has been substituted for the finger-catch and split pin. The guide-bolts, which were formerly movable and which had to be removed in dismounting the mechanism, are now stationary, the guide-grooves having been run out at the front face of the block. The number of parts connected with the operating handle has been reduced to two, viz., the handle and its locking spring, both of which are included in the 12 tactical pieces composing the entire mechanism.

The following description applies to the present standard Driggs-Schroeder guns, as illustrated by Mark II of 1- and 3-pounders, Marks II and III of 6-pounders, and all 9-pounders, 14-pounders and 4-inch, and all field and landing guns except Mark I of 6-pounders. In the course of the description, attention is called, where necessary, in brackets, to parts that are of different design in the earlier guns, such as Mark I of 1-, 3- and 6-pounders (H. P.), and 6-pounder Field.

The transverse hole through the block for the axial or main bolt, B, is lengthened in a nearly vertical direction to permit the block to descend and disengage the bands from the corresponding grooves in the breeeh. The main cam, C, has a hexagonal bearing on the main bolt; it will be noticed, in Plate II, that its front upper face takes under an interior surface in the block and sustains it in the upper or "closed" position. This interior surface inclines upward to the rear, and when the cam is turned to the rear, for opening, this permits the block to descend, the lower rear corner of the cam taking on the interior bottom surface of the block and forcing it down. Conversely, in the latter part of the closing motion, that same upper front face taking under the incline, pushes the block up into place, and then, slightly passing the center of rotation, takes under the curved surface; in this position the downward thrust of the block has no tendency to turn the cam backward, and it is therefore held rigidly and securely in place.

When the main cam has been turned and the block pushed down sufficiently far to clear the bands from the grooves, the semi-circular score in the upper rear corner engages the pin, L, in the block, and, from that time on, the movements of the two are in unison, rotary to the rear around the main bolt, the rear face of the block finally resting on the tray, T, leaving the chamber open.

The firing pin is marked F; the firing spring lies to the rear of its upturned head, coiled around its stem; the full-cock stud will be noticed under the rear part; (the half-cock stud is also placed there if desired, to the rear of the full-cock). The sear, S, actuated by its spring, presses up against the firing pin and engages the stud when it is forced to the rear. The point of a lug projecting from the under side of the firing pin rests always in a circular groove hollowed out in a vertical longitudinal plane in the upper rear face of the main cam. When the cam is turned to the rear, the first effect produced is to push back that lug and the firing pin, so that the point of the latter is brought safely within the face of the block before it begins to descend; the motion continuing, the firing pin is retracted until the full-cock stud passes beyond the sear and is engaged by it. This compresses the firing spring. When the sear is pressed down, the firing pin is released and the spring impels it forward. The eye formed in the rear end of the pin is for use in cocking without opening the breech, a hook to engage it being formed in one end of the combination wrench (accessory chest); it also receives the hook of the drill-washer support. [In the Mark I of 3- and 6-pounders a finger-catch is screwed on the rear end of the firing pin for cocking; the drill-washer slips on over and in front of it.] For construction purposes the firing point is made separate from and screws into the body of the firing pin.

The extractors, E, one on each side, lie flat against the rear face of the tube of the gun, and in recesses in the front face of the block. They revolve on pivots, P, which work in sockets formed in the curtain. The rear sides of the tails of these extractors form cam surfaces, the curves being slightly eccentric to the main bolt in the upper position, so that after the block has been lowered, during its rotation its cam surfaces take upon the extractor tails, pressing them forward and consequently bringing the heads to the rear and throwing the cartridge case out. These bearing surfaces are so adjusted that the motion is slow at first, with a powerful leverage; toward the latter part of the rotation of the block the motion imparted is quick.

But one thing now remains to be explained. The block, as already described, has a certain amount of vertical motion with regard to the main bolt, and must be kept in the lower position relative to it during the rotation. To this end a pin or "guide-bolt," G, is screwed in through each side of the curtain, projecting into a guide-groove cut in each side of the block; this groove is so shaped that the bolt permits only the vertical and rotary motions of the block in succession, thus confining it in its movement. It also performs one other function: In closing the breech, after the rotary motion of the block ceases the vertical motion is produced by the upper corner of the cam pressing on the interior inclined surface of the block; for the purpose of easing an otherwise abrupt change of motion (from rotary to vertical), the part of the guide-groove where the guide-bolt is at that instant is *camed* so as to make the bolt start the block upward gently before the corner of the main cam touches the incline; the motion of rotation thus merges gradually and easily into that of vertical translation. For facility in assembling, this groove is run out at the front face of the block, [except in Mark I of 3- and 6-pounders.]

Among the principal details may be mentioned the following:

The bands on the top and sides of the block, and the corresponding grooves in the breech, are inclined about 2° 30′ to the front and upward; so that as the block is pushed up in position in closing, it is also pressed forward and presses the cartridge case home, and in opening it readily detaches itself from the head of the case.

There is a spring-lock on the handle, which, when the breech is closed, prevents the main bolt and block from moving under stress of any kind except that applied directly to the handle. This lock consists of a double-acting flat leaf-spring which is simply pushed into a longitudinal slot in the main bolt under the handle. There are lugs on it corresponding to certain mortises in the bolt and gun-body, in such manner that when in place it holds the handle on securely, and prevents the bolt from turning except when liberated by the turning of the handle through a certain arc at the beginning of its rotary movement. The snapping of the spring into place indicates by the sound when the block is in place and locked. [In Mark I of 1-, 3- and 6-pounders a separate locking piece and spring were placed on the end of the main bolt for the purpose.]

To facilitate assembling, the front face of the block contains a heavy face-plate, K, easily removed and secured; the cam, firing pin and spring, and sear-spring are removed and replaced there.

The sear, S, which slides vertically in the middle of the rear face of the block, has a projecting eye fashioned in the rear side near the lower end, into which the wire cable firing laniard is hooked. In the 1-pounders this laniard has a pear-shaped handle of convenient size, and the firing is done by a straight downward pull. In other calibers the laniard leads to and is connected with the trigger in the pistol-grip, which in the recoil-mounts is placed under the stock; as the latter attaches to the stationary part of the mount, the hand of the firer receives no shock. [In 3-pounders Mark I and a few early 6-pounders, the sear, instead of having a laniard, has an arm extending to the side of the block, with a finger at the end which is pressed downward by a toe on a rockshaft connected with the trigger by a laniard; the trigger is in the pistol-grip on the stock.]

The sear-spring, M, is formed of the tail of the small through-bolt or pin which locks the face-place in position. This pin goes through the entire length of the block from front to rear; the rear portion, which is tapered to form a spring, engages in a lug formed on the side of the sear, and presses it up, at the same time being held in place by it. [In Mark I of 1-, 3- and 6-pounders the sear-spring is a small spiral spring acting in a vertical recess under the sear, the face-plate being held in place by independent screws.]

Operation.

The operating handle is on the left side in all calibers below and including the 14-pounder. In the others it is on the right side of the breech.

To open the breech, eject the empty case and cock the firing pin, the handle is turned smartly to the rear. The first part of the movement unlocks the system without moving the main bolt, the handle being loose on it through that small angle; it then engages the bolt and turns the main cam. During the progress of this movement the firing pin is retracted until the sear catches in front of the full-cock stud; the extractors revolve on their pivots, heads to the rear, ejecting the empty cartridge case; the block finally lands on the tray.

A fresh cartridge is then placed in the chamber and the handle turned to the front. This closes the breech, by first turning and then raising the block, and locks it, the firing pin being left in the full-cock position.

If it is not intended to fire, the piece should then be half-cocked, if the firing pin be adapted to that operation. To do this, hold back the firing pin by means of the combination wrench and the eye in the rear end of the firing pin, and press the trigger, easing the firing pin forward until the sear takes against the half-cock stud. To full-cock at any time, pull back the firing pin in the same way until the sear takes in front of the full-cock stud.

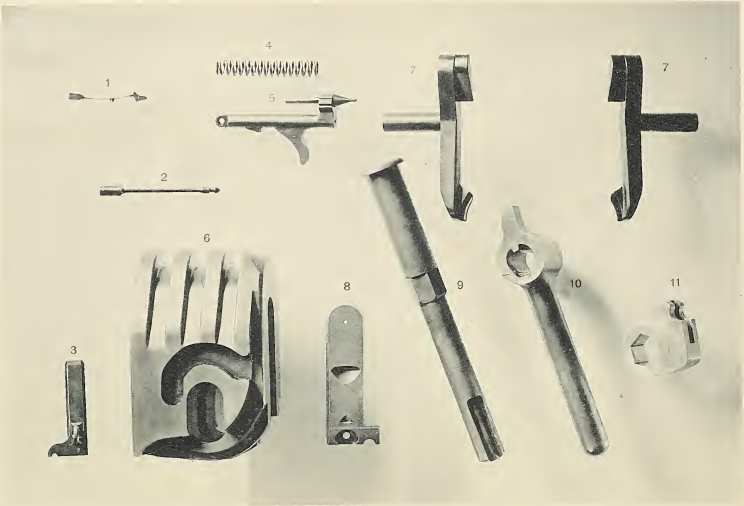
If the exercise is to be carried on without ammunition, the drill-washer, with its support, should be placed on the firing pin so that the former shall take against the rear face of the block in snapping and save the firing point from striking the face-plate, as this would injure it in time. To do this, full-cock the firing pin, and put on the drill-washer-support and drill-washer, hooking the support into the eye; the firing pin can then be snapped back into place. [In Mark I of 3- and 6-pounders, having a finger-catch on the rear end of the firing pin, the cocking is performed by retracting with that; and the drill-washer, when used, is simply slipped on in front of the catch.]

It is found best to leave the drill-washer on at all times except when actually firing, so as to preclude possibility of injury from idle snapping by careless or irresponsible persons.

To Dismount and Assemble.

Full-cock the piece (either with the combination wrench or by opening and closing the breech). Take off the bolt-handle and locking spring; hook the

PLATE III.



MECHANISM DISMOUNTED.

1. HANDLE LOCKING SPRING. 2. SEAR SPRING. 3. SEAR. 4. FIRING SPRING. 5. FIRING PIN. 6. BREECH BLOCK.
7. EXTRACTORS. 8. FACE PLATE. 9. MAIN BOLT. 10. OPERATING HANDLE. 11. CAM.

combination wrench into the eye of the firing pin, and, holding the block by that, aided by the other hand underneath if necessary, withdraw the bolt; lay the block on its side; withdraw the combined sear-spring and face-plate-lock from the front; remove the face plate; turn the block face down upon a wood surface, press down the sear, thus liberating the firing pin and spring; lift the block up, and the cam, firing pin and firing spring will drop out clear.

NOTE.—Be sure to cock the firing pin before trying to take off the face-plate; otherwise the firing point will be bent or broken by the plate. If there is no wood surface convenient for snapping the firing pin into, hold it back with the wrench and ease it forward on removing the sear.

[In Mark I of 3-pounders and in 6-pounders before No. 50, the guide-grooves are not run out at the front end of the block, and therefore the guide-studs must be backed out with the screw-driver far enough to clear the grooves. In 3-pounders Mark I and a few early 6-pounders Mark I the sear spring, being a small spiral spring independent of the face-plate-lock, is removed after the face-plate, firing pin and firing spring have been removed; push the sear-plug up a little and turn it until the stud is fair for coming out, when it and the spring will come out together.]

To assemble the mechanism, proceed in the reverse way. Put in successively the firing spring, firing pin and main cam; the front side of the latter is marked "OUT." Put on the face-plate, being careful to keep the firing pin cocked while so doing. Put in the combined face-plate-lock and sear-spring, and engage the rear end in the lug in the lower end of the sear. An arrow on the head of the main bolt being brought in line with the arrow on the curtain indicates the proper "square" for the hexagonal bearing in the cam, so that the handle will be in proper position when locked on the bolt.

Automatic Ejection.

With the object of increasing the rate of fire a device has been applied by which the counter-recoil, that is to say the motion of the gun in returning to the firing position after the recoil, is utilized to open the breech, eject the empty case and cock the firing pin. When the loading is complete the piece is closed by hand as usual. In fact, in this position the piece can be opened and closed at will.

With the exception of a movable pin and its spring, (outside the gun) no change nor addition has been made to the mechanism, and on the mounting the only addition is a plate and the arm, from the rocking slide, to support it.

In general terms the device and its application are as follows: A plate is secured to the rocking slide, extending to the rear parallel to the breech, and close to it. A spring-stud playing in a recess on the bolt-handle is pressed against this plate and slides along it during the recoil motion; at the end of this travel it has reached a mortise in the plate into which it is pushed by the spring; during the first part of the counter-recoil the spring-stud taking against the front side of this mortise is arrested by it and causes the handle to revolve to the rear, thus opening the breech; at the end of this action the spring-stud reaches a part of the mortise from which it is free to emerge, sliding up an incline and reaching the surface of the plate by the time the counter-recoil is completed. The handle is now free to be moved by hand for operating the breech-mechanism.

A considerable saving of time is effected in this way, as the loader does not have to wait to open the breech, but stands by with the new cartridge in hand and inserts it as the piece comes to rest.

Rifling.

All Driggs-Schroeder guns are rifled with an increasing twist. The curve connecting the initial and final angles is a semi-cubical parabola. The final twist is dependent upon the anticipated muzzle velocity; as far as is known the Driggs-Schroeder guns were the first to have as rapid a pitch as one turn in twenty-five calibers.

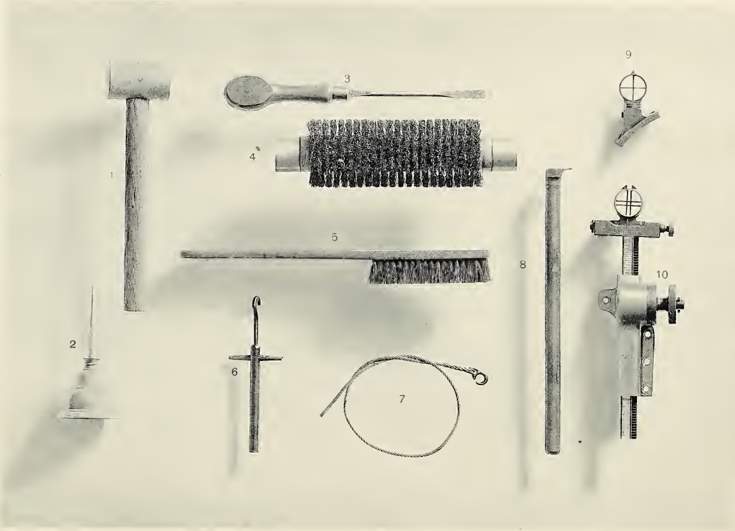
Sights.

The sights used on Driggs-Schroeder guns, Plate IV, have been designed with the object of securing fine, accurate alignment, and at the same time providing the ordinary notch and point for use at close quarters or when rapidity of fire is more important than extreme accuracy.

The drift is compensated for by setting the sight-bar at a permanent angle to the left.

To compensate a sight for all the combinations of speed of ship, speed of enemy, wind across the line of fire, etc., would necessitate an instrument so complicated that it would be far from serviceable. The best that can be done is to give the eye-piece of the rear sight an independent lateral motion, and leave the setting of it to be determined as nearly as possible by trial shots. To this end the cross-bar is graduated in spaces representing 10 minutes of horizontal arc. This will assist the officers commanding the guns, who are able thereby to

PLATE IV.



SIGHTS AND ACCESSORIES.

1. MALLET. 2. OIL CAN. 3. SCREW DRIVER. 4. SPONGE BRUSH. 5. CLEANING BRUSH. 6. FIRING PIN WRENCH. 7. FIRING LANYARD. 8. HAND EXTRACTOR. 9. FRONT SIGHT. 10. REAR SIGHT.

designate the amount the eye-piece is to be moved, while the graduations also form a basis for any computations they may wish to make for their own convenience. In the opinion of the American Ordnance Company, it is a mistake to place these sliding leaves on the sights of secondary battery guns, but they are at present generally called for in the specifications of guns ordered for Government service.

An essential feature of sights for rapid-fire guns is that they shall be capable of rapid changes of setting and with but one hand. They must also remain securely in the position in which they are left. The present sights accomplish this.

For accurate shooting the rear sight has double cross-wires, and the front sight single wires. The advantages of this arrangement are that the gun can be pointed almost as accurately as with a telescopic sight, and that there is a clear field about the target. This latter point is important, as it allows the gunner to anticipate the motions of the ship.

Each space on the sight-bar represents 100 yards in range when using the service charge. To set the bar for any desired range, disengage the operating wheel by pulling it to the right with the right hand; then turn it until the desired graduation is on a line with the top of the sight-box. As soon as the wheel is let go it will engage the teeth on the side of the sight-box and remain in that position, thus preventing the bar from being shaken down.

The notch on the top of the eye-piece and the point on the top of the front sight are used for quick sighting or as a finder; with them the piece may be approximately pointed, and, if there is time, the aim perfected with the cross-wires.

Accessories.

The accessories, Plate V, consist of the following :

1. Hand extractor.
2. Screw-driver.
3. Combination hook and wrench.
4. Babbitt metal mallet.
5. Oil can.
6. Drill-washer support.
7. Drill-washers.
8. Cleaning brush.
9. Bristle sponge and rod.

For convenience of handling and stowing, these parts, excepting the sponge-rod, are kept in an accessory chest. With the exception of the drill-washers, they require no explanation. The washers are of rubber, and for drill purposes are put on the rear end of the firing pin. With the drill-washer on, the piece may be snapped without danger of breaking the firing point; if snapped without this washer, the point is liable to injury.

If specially called for, a drill-apron will also be supplied. This is a tanned canvas receptacle, adjusted to hang under the rear of the breech, to save the deck by catching the drill-cartridges when ejected from the gun during drill.

Driggs Rolling Block.

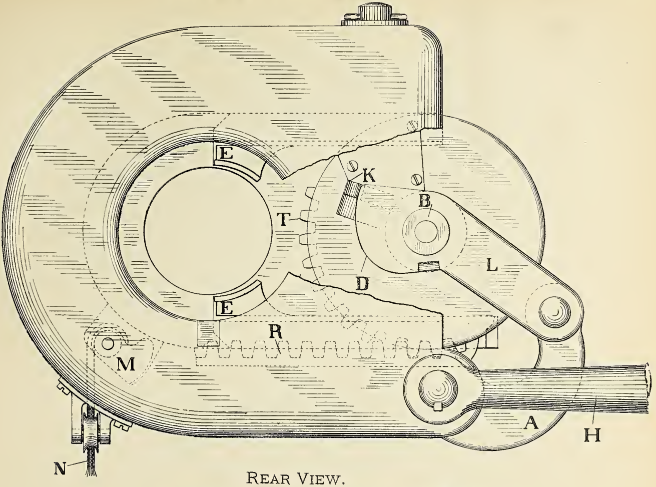
While it is not probable that 10- and 12-inch guns will come to be classed as rapid-fire guns in the present acceptation of the term, it is anticipated that a breech-closure adapted to metallic case ammunition will be eventually applied to them in order to secure the advantages of the best known obturation and the simplest form of firing attachments. The Driggs Rolling Block has been designed with a view to minimize the effort required to move the necessarily heavy blocks of those large calibers.

The general action of the mechanism will be readily understood from Plate V. The block is cylindrical, and has projecting ribs which engage, in the closed position, in grooves within the breech, as in the Driggs-Schroeder system. To open the breech this block is rolled to the right within the curtain, leaving the prolongation of the bore open for the ejection of the empty cartridge case and the insertion of a new charge.

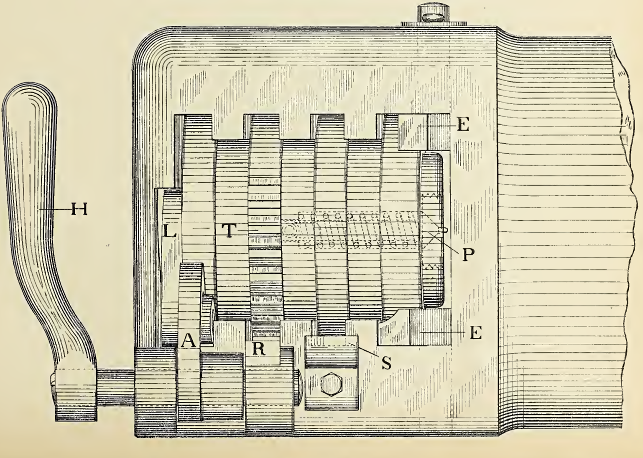
Fig. 1 gives a rear view of the breech, with the block rolled open, the breech being broken away in the drawing to show the block. Fig. 2 gives a vertical side view from the right. H is the operating handle, the shaft of which is journalled in and through the curtain of the breech, and carries on its inner part a curved arm A; the other end of this arm is pivoted to one end of the link L, the other end of which grasps a boss in the center of the rear face of the breech-block, B. In turning the operating handle, therefore, the motion is transmitted through the arm and link to the block and causes it to roll in or out as the case may be, making about a quarter of a revolution either way. Returning to the closed position, the pivoting point of the arm and link passes and comes slightly below the straight line between the axis of the handle-shaft and the axis of the

PLATE V.

DRIGGS ROLLING BLOCK.



Rear View.



Side View.

block, and rests upon the lower wall of the breech-hood thus securely locking the breech-block.

To prevent the block from rolling entirely out of the gun, a stop, S, is bolted to the side of the breech just below the opening, extending far enough up for the purpose. A toothed segment, T, is set in one of the ribs of the block, so that the pitch-circle of the teeth coincides with the circumference of the rib; the teeth of the segment mesh with a rack, R, secured in one of the grooves of the breech, so that the block cannot slip in rolling, and when brought to the closed position will always resume exactly the same radial inclination. A spring-lock is fitted to the handle, similar to that of Driggs-Schroeder guns.

The ribs of the block and corresponding grooves of the breech are formed at an angle of about 2° from a line normal to the axis of the gun and block (as in the Driggs-Schroeder fermeture), so that, in rolling out, the block also moves a little away from the cartridge. One side of the front face is beveled off, so that as the block rolls in, if the cartridge should not be entirely in, the bevel will be the first part to come in contact with it and will force it home as the block moves in.

The extraction is on the same principle as that of the Driggs-Schroeder system. The two extractors, E, lie horizontally, one in the upper and the other in the lower part of the breech cavity, and revolve on vertical pivots which work in recesses in the curtain; the pivot-spindle of the upper one extends up through the curtain and is sustained by a key and washer on top. The tails of these extractors form cam surfaces developed on curves such that the block in rolling out will impart a slow extracting motion at first, and a quick ejecting one at the end. The block does not begin to take on them until it has rolled out far enough for the bevel on the side of the front face to permit the cartridge case to move slightly to the rear. As the upper part of the block moves much faster in rolling than the lower, the cam surfaces of the two extractor-tails are differently developed so as to make the motion of the extractor-heads the same.

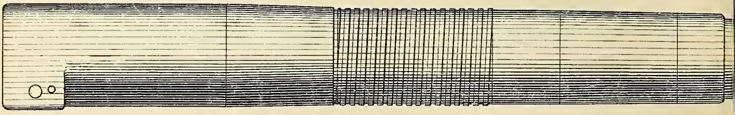
The breech-block is bored through centrally for the cylindrical firing-pin, F, which with its coiled spring, is put in from the front face, a removable face-plate being fitted for the purpose. By means of a bell-crank lever, the firing pin is retracted in opening the breech, the power for the purpose being applied by the *camed* end, D, of the link L, which bears upon the rear end of the bell crank, K, as it rolls out and forces it away. A spring-sear holds the firing pin retracted. For firing, a tumbler or hammer, M, fitted with a firing laniard, N, is located in the breech wall, and trips the sear when the laniard is pulled. The immediate, first motion of the operating handle, for opening the breech, transmitted through the arm and link, retracts the firing point within the face of the block before acting to make the block move; and in the reverse operation, of closing, the *camed* end of the link remains as a guard over the bell-crank until the block has reached the locked position.

By means of a simple wrench, included in the list of accessories, the bell-crank lever may be turned and the firing pin cocked without moving the breech-block.

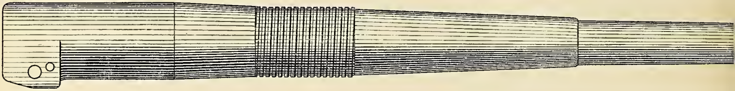
It will be observed that the same elements of safety and certainty are embodied in this design that characterize the Driggs-Schroeder fermeture.

CALIBERS OF DRIGGS-

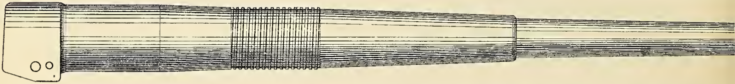
4-Inch.



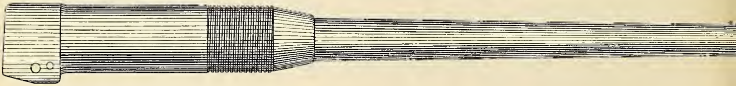
9-Pounder.



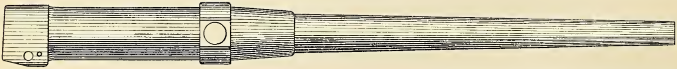
6-Pounder, Mark III.



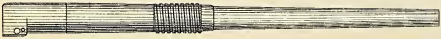
6-Pounder, Mark II.



3-Pounder.

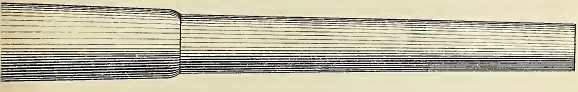


1-Pounder.

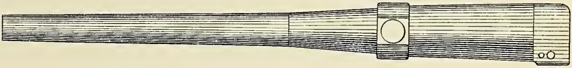


CHROEDER GUNS.

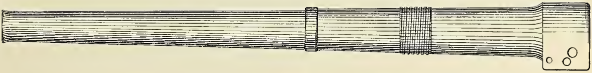
PLATE VI.



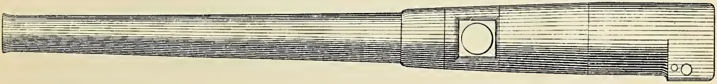
6-POUNDER FIELD GUN.



12-POUNDER FIELD GUN.

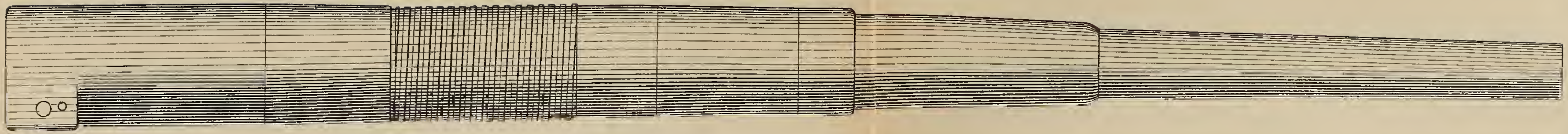


3.2-INCH FIELD GUN.

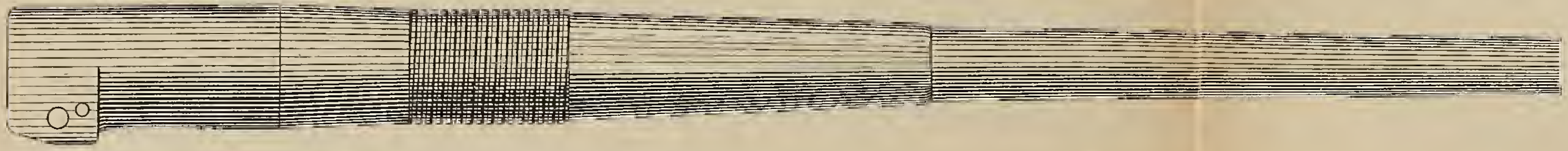


CALIBERS OF DRIGGS-SCHROEDER GUNS.

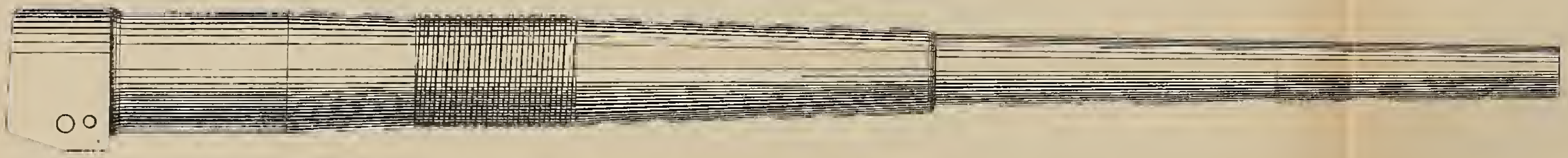
4-Inch.



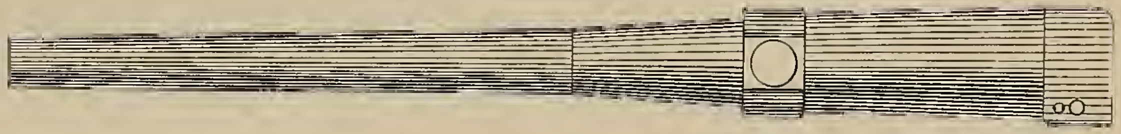
9-Pounder.



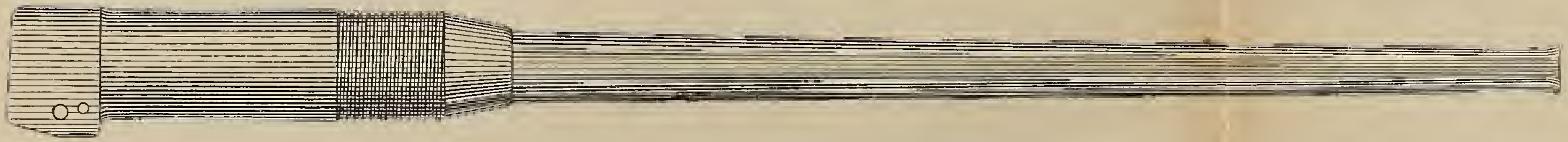
6-Pounder, Mark III.



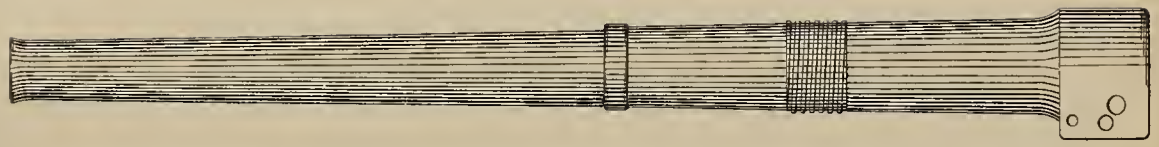
6-Pounder Field Gun.



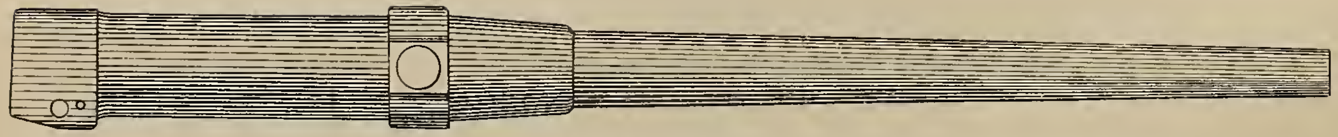
6-Pounder, Mark II.



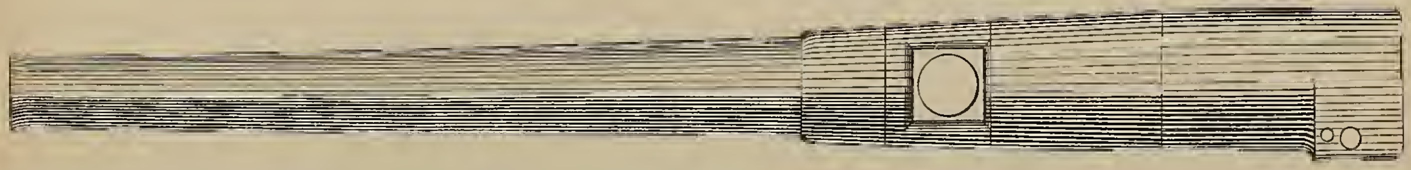
12-Pounder Field Gun.



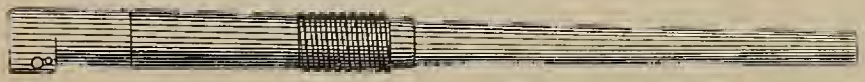
3-Pounder.



3.2-Inch Field Gun.



1-Pounder.



CHAPTER III.

CALIBERS OF DRIGGS-SCHROEDER GUNS.

Plate VI.

Driggs-Schroeder guns are made of many calibers, from 1-pounders (Low Power) weighing 88 pounds, to 4-inch guns weighing 3,613 pounds and firing a projectile of 33 pounds. The system is capable of expansion to much heavier guns than the 4-inch, but the demand for larger rapid-fire guns has yet been too limited to warrant the building of them by private companies in the United States. Designs are, however, complete for 5-inch and 6-inch.

In all calibers, the stated weight of breech-block includes all lifting parts of the mechanism.

1-Pounder, Mark I.

In 1889 the U. S. Navy Department invited the construction, by different firms, of a high power 1-pounder to throw the same projectile as the short gun of another system which had been in use up to that time, but to be endowed with superior ballistics. The limitations to the design were a maximum weight of 100 pounds and ability to stand a chamber pressure of 14 tons; the ballistics to be the best obtainable under these conditions.

In response to this call a Driggs-Schroeder gun was produced, (Mark I), of the weight allowed, with a 40-caliber bore, and burning a charge of 140 grammes. (No other gun of equal power was presented of less than 20 per cent. greater weight).

This charge, together with the increased length of bore, raised the initial velocity from 1,313 f. s. to 1,800 f. s., and consequently increased largely the accuracy and penetration.

The gun-body is composed of three parts, the tube, jacket and hoop. The general arrangement of these is the same as that in all Driggs-Schroeder guns, except that the hoop is both screwed and shrunk on; that is to say, the rear portion of the hoop is threaded and fits a corresponding thread on the tube and jacket, thus locking the parts together.

1-Pounder, Mark II.

One hundred and twenty pounds being subsequently allowed by the U. S. Navy Department as the proper weight for high-power 1-pounders, a Mark II Driggs-Schroeder has been produced of that weight and adopted as the standard for that caliber. This gun has a length of bore of 50 calibers, by which the initial velocity is increased to 1884 f. s. (with the same loading), and the breech-mechanism is of the standard type described in preceding pages.

The range-table and other details of this gun will be found in the tables at the end of this book.

1-Pounder, Low Power.

This is not unlike the high-power guns in appearance, but the bore is shorter, and it burns a lighter charge. It is made of one forging, and the weight is 88 pounds, including the trunnion-band which is screwed on. The powder charge is the same as that used in the old short model previously referred to, but the increase in length of bore gives an increase of velocity.

The design was introduced as a suitable gun for yachts and light vessels. As the breech-mechanism is identical in design and interchangeable with that of the high-power 1-pounder, it is also an excellent gun for the Naval Militia, as it furnishes an exact counterpart of all the main features of the Naval gun except as to velocity, while it and its ammunition can be manufactured at a less cost.

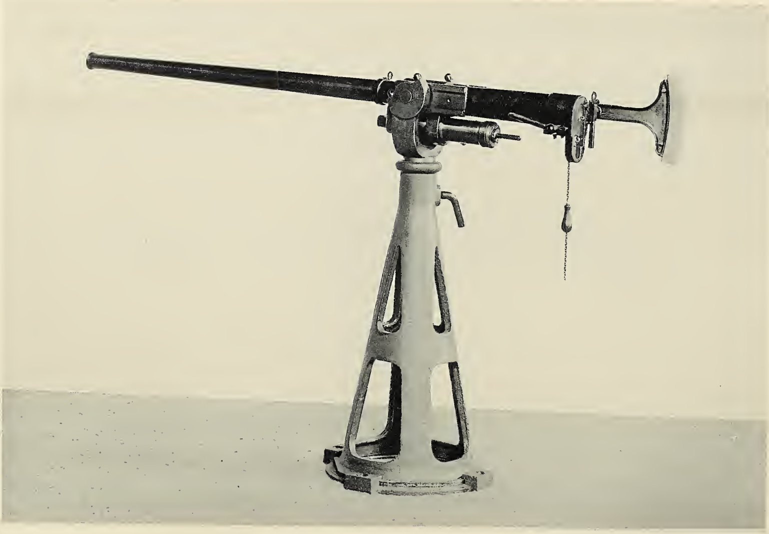
The earlier guns of this class were fitted with the Mark I mechanism; but the later and present ones have the standard Mark II block.

The range-table and other details will be found in the tables at the end of this book. An examination of the column of steel perforation in the range-table will show that although of low power as compared with the built-up guns, this weapon is capable of very effective work, being able to perforate 1¼ inches of steel at the muzzle, and ¾ inch at 1,000 yards.

3-Pounder.

Of the several calibers of rapid-fire guns the 3-pounder was for a long time the most efficient for its weight, and was in fact the only one that could be classed as a high-power gun. Recently rapid-fire guns of larger calibers have been built which attain equal velocities, and with smokeless powder surpass it.

PLATE VII.



1-POUNDER ON DRIGGS RECOIL MOUNT.

In service it was found that the 6-pounder could be fired as rapidly as the 3-pounder, while the shell had a much more destructive effect than the lighter one, and although the heavier shell had less velocity, it was not so far behind as to offset the advantages. For these reasons the 6-pounder has become a more popular caliber for Naval service, though in light vessels the 3-pounder is still used.

One objection raised to the use of the 3-pounder was the violence of its recoil and the shock upon the deck fastenings; but this has been overcome by the adoption of recoil mounts, on which all these guns are now placed.

The 3-pounder Driggs-Schroeder gun was designed to use the same ammunition as that which was already in use in the U. S. service, so as to prevent confusion in the supply to the guns and to avoid the military error of multiplying the classes of ammunition.

The construction of the breech-mechanism made it possible to greatly improve the ballistics of the piece without increasing the weight beyond that of the guns then in use. The gun-body was slightly strengthened along the chase, to allow the use of slower powders in case they should be developed, and the length of the bore was increased five calibers. This last change increased the I. V. of the projectile over 70 f. s. The difference could be made still greater by the use of powder specially suited to the guns of this caliber, but it was necessary to use the ammunition which was in service at the time the Driggs-Schroeder was introduced; for this reason the velocities are somewhat under what they would be had a powder been developed suited to the piece.

The range-table and other details are given in the tables at the end of this book.

6-Pounder, Mark I.

The 6-pounder is at present the most generally used of all the calibers, some naval vessels carrying as many as 30 of them.

As with the 3-pounders, the guns built for the U. S. Navy had to be so constructed as to use the ammunition then in service. The consequence has been that these pieces are much less powerful than guns that have been designed (Mark III), and which could be produced were this restriction removed. Still, the Driggs-Schroeder Mark I, the first produced, shows much better ballistics, even with the same loading, than those met with in service before its introduction.

The lightness of the moving parts of the breech-mechanism, taken with the peculiar motion of the block, makes this piece very easy to manipulate. So little effort is required that one man easily performs all the motions of loading as well as operating the breech-mechanism. In the 1894 trial at Sandy Hook, 32 shots were fired in one minute, the crew consisting of two men and a third to pass ammunition. This can be exceeded, of course, by using the automatic ejection attachment.

With the introduction of recoil mountings, first applied to this caliber, it became necessary to devise a firing mechanism which would be disconnected from the piece. The pistol grip on the gun being no longer available on account of the recoil, it has been placed on the shoulder-bar of Driggs-Schroeder guns; and the sear connected with it by a laniard. This arrangement has the double advantage of furnishing a handle by which to train the piece, and a means of firing by which the hand of the gunner is not affected by the shock of recoil. Also both hands are in position to train the piece and at the same time steady the body, the left grasping the handle on the deflector, and the right the firing handle with finger on trigger.

The details are in the tables at the end of this book.

6-Pounder, Mark II.

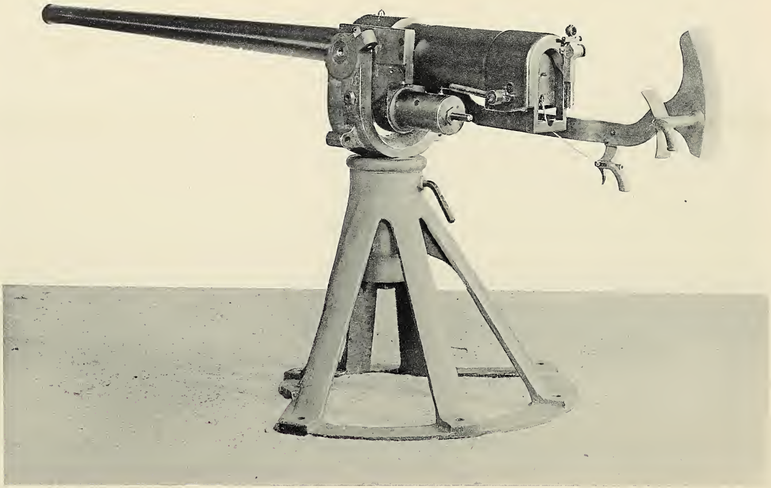
This is a higher powered gun than the Mark I, having a 50-caliber bore; the ammunition is the same. The breech has the standard Mark II mechanism. The increase in the length of the bore has raised the I. V. to 1914 f. s. The weight of the piece is 786 pounds.

The range-table and other details will be found in the tables at the end of this book.

6-Pounder, Mark III.

This gun was mentioned in the first edition of this book as Mark II. The piece produced by the changes given immediately above has, however, been designated as Mark II, and the term Mark III is now applied to this proposed design.

The breech-mechanism of this Mark is the same as that of the standard Mark II gun and interchangeable with it; but the tube and jacket have been differently proportioned and the chase strengthened. These changes produce a



6-POUNDER ON DRIGGS RECOIL MOUNT.

much more powerful gun, capable of burning 60 per cent. more powder, the final result being an increase of 300 f. s. in initial velocity.

The construction is shown on Plate I, and the general data will be found in the tables at the end of this book.

The design has the disadvantage of introducing another size of cartridge case into a service using the other 6-pounder; but when only one pattern is mounted on board an individual ship, or in a single shore battery, this objection is less important; while in countries or organizations that have not yet adopted a 6-pounder, the objection disappears entirely. The projectile is the same as for Marks I and II.

6-Pounder Field Gun.

This gun was built as a field gun for use at the U. S. Naval Academy, and was constructed with the special object of reducing the weight to a point that could be handled entirely by a crew of midshipmen.

The gun is not built up, but of a single forging. The shell is the same as that used in the high-powered guns, but the powder charge is much reduced, as the strength of the piece does not permit the use of the full charge.

The mounting is of the usual Naval pattern, carrying ammunition and supply boxes.

12-Pounder Field and Landing Gun.

This gun was originally designed for a Landing Gun for the Navy, and one of the first requirements was, therefore, that the weight should not exceed about 350 pounds, that being generally considered as a desirable maximum, based upon tactical considerations. Subject to this limitation the object was to secure the best ballistics possible, coupled with rapidity of fire and effective mine power.

The recent adoption of smokeless powders and small calibers has so extended the effective range of infantry fire that it is now necessary that field artillery should also have a fairly long range. With a given weight of gun and projectile this is facilitated by reduction of bore; but a limit in this direction is imposed by the obligation of not exceeding a fair proportion of length to diameter of shell (to secure good flight), and of retaining a diameter of shell sufficiently great to afford space for a good burster.

After giving due weight to the various conflicting requirements, a caliber of 2.76″ was adopted, with which a shell of about 12 pounds could be obtained associated with a length of less than 4 calibers; and a built-up gun was constructed of 25 calibers length of bore and of the maximum strength obtainable on a weight of 350 pounds. With these characteristics the initial velocity obtained was 1,300 f. s.

A special feature, carefully worked out, is that the breech-block and all the parts of the mechanism, except the extractors and the main bolt, are identical with and interchangeable with the block and mechanism of the 6-pounder Mark II. The great advantage of such interchangeability need not be dwelt upon.

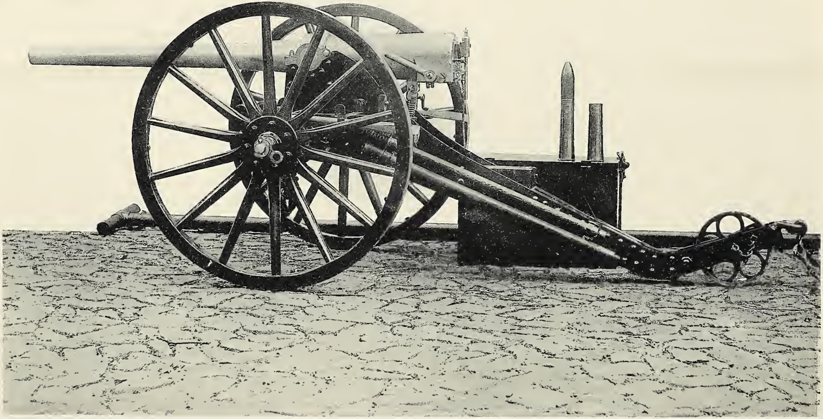
To increase to the utmost the offensive and defensive power vested in a ship's secondary battery, and also to provide convenient places for keeping these landing guns on board, adapting rings are provided for them to fit either the 3- or 6-pounder mounts; or special individual mounts are furnished if desired. And shoulder-rests are provided for such as it is proposed to place on ship mounts. The gun being of less than one-half the weight of the high-power 6-pounder, and having a much less violent recoil owing to being of less power, it may be mounted in many places of comparatively light construction, where a more powerful gun could not be installed. In this way, when not in use on shore, place may easily be found for it at the rail without interfering with other guns, and the defense against torpedo-boats, or similar attack, proportionately increased.

While not designed as an armor-piercing gun, the column of perforations of steel in the range-table shows that it is an efficient weapon against torpedo-boats throughout such ranges as it is believed these will be seen at night, or at which there is fair probability of hitting in the day time. This table as computed assumes the use of an armor-piercing projectile, and it would seem judicious to have some such ready for this service. The common shell will, however, undoubtedly perforate the skin plating and bulkheads of torpedo-boats, and their comparatively large mine-power should prove very effective.

It is believed that in this gun has been effected the best compromise possible between the conflicting requirements of good range, effective weight of projectile, good mine-power, and moderate weight of gun. Higher velocity could be obtained with lighter shell, or smaller bore, or both; but a lighter shell would have less range and a smaller bursting charge; and a smaller caliber would require the shell to be longer (for equal weight), probably to an extent that would affect the smoothness of flight.

It has been represented by rivals that a larger caliber than that adopted

PLATE IX.



6-POUNDER DRIGGS-SCHROEDER FIELD GUN.

would be preferable, but the criticism is not considered valid because the burster is about 7 per cent. of the total weight of the shell, and the length (about 3.9 calibers) cannot be called excessive. In regard to another feature sometimes considered to be affected by the caliber, viz., the dispersion of shrapnel, it is the opinion of the American Ordnance Company that a prime factor in the dispersion of shrapnel balls is the centrifugal force applied to them by the spin of rifling, and it is believed that, other things being equal, the dispersion and general effect of a 2.76-inch shrapnel with a muzzle velocity of 1,300 f. s. and final rifling curve of one turn in 25 calibers (which gives a spin of 226 turns a second) will be greater than that of a 3-inch shrapnel with a reduced initial velocity and range. In the case of the 2.76-inch gun, the centrifugal velocity, when released, of a ball whose center is one-half inch within the circumference, considered in connection with the velocity of translation, causes an angle of dispersion of a little over nine degrees at the muzzle, in addition to the effect of the burst; at a greater range the cone of dispersion is much broader as the remaining velocity (of translation) is much less, while the velocity of rotation is not diminished in the same proportion.

The landing or field carriage for this gun is in essential points a new departure for field mounts, differing from the usual practice up to the present time in the methods employed to secure accuracy and also rapidity of fire by modifying and reducing the recoil.

To insure accuracy the object sought was to eliminate the jump so prevalent in guns of this class; and this has been effected by allowing a limited recoil in the carriage, so that the projectile shall be clear of the muzzle before the carriage begins to move sensibly over the ground. It is also evident that unless the recoil over the ground be checked, so that time will not be lost in returning the gun to battery after each shot, a rapid-fire gun will be so only in name. To cover this point the recoil over the ground has been successfully mastered. Detail descriptions of the first landing carriage and of the model of 1895 are given farther on; and the range-table and other details of the gun are given in the tables at the end of this book.

For the Naval Militia, while combining the means of drill for both ship and shore mounts, these landing guns possess a farther advantage in that they are the best adapted to the nature of active service most likely to be required, viz.—suppression of riot, either ashore or afloat. Their larger caliber and concomitant features produce both moral and material effects upon bodies of men of greater value than the lighter and relatively more powerful 1-pounders. At the same time, weighing only 350 pounds, they are easily transported and handled.

9-Pounder.

This gun was designed mainly for land service, being specially adapted for water batteries, etc., defending mine fields or channels against countermining boats or light vessels. It has a long range and is capable of perforating heavy gun shields and such armor as small vessels can carry, while it is light enough to be readily pointed from the shoulder in the same manner as a 6-pounder. Fitted with the automatic ejection, this piece commends itself strongly for harbor defense; and the general tendency being now toward an increase in the calibers of secondary battery guns on board ship, it is possible that it may come in favor for that service.

Details will be found in the tables.

3.2-inch Field Gun.

The general design of this gun is that common in the United States Army, the only change being in the breech-mechanism. This is of the standard Mark II Driggs-Schroeder type, and is but slightly heavier than the high-power 6-pounder.

Mounted on the Driggs minimum-recoil Field Carriage, this piece is a most efficient weapon and meets, more completely than any other type, all the service requirements of this class of ordnance.

A complete description of the carriage will be found on page 51, and the range-table and other details of the gun are given at the end of this book.

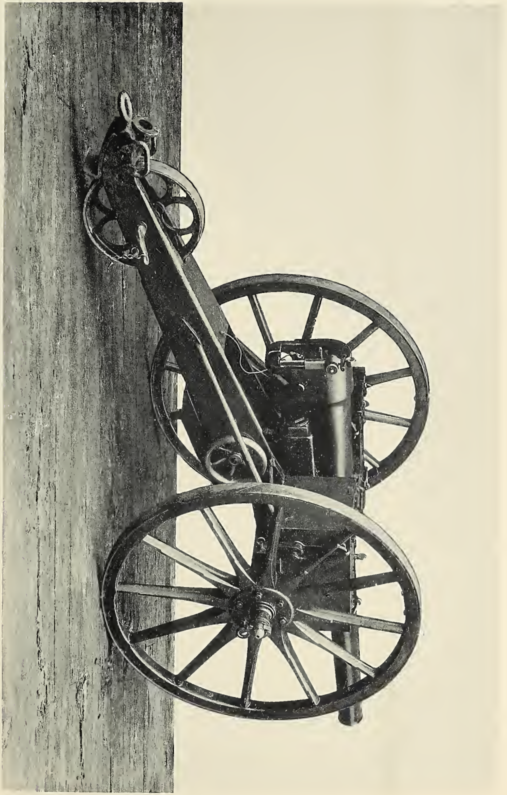
14-Pounder.

This caliber is intended for land service or for the naval service where greater power is required than can be obtained from the lighter guns.

Details are given in the tables at the end of this book.

4-Inch, or 33-Pounder.

The 4-inch Driggs-Schroeder gun is intended for the auxiliary batteries of battle-ships or main batteries of unarmored vessels, and for land service mounted in fixed positions, especially for boom- and mine-defense.



12-POUNDER DRIGGS-SCHROEDER FIELD GUN.

This gun is too heavy to be pointed usually from the shoulder, but the same object is attained by means of a directing bar having two handwheels, one of which is intended for lateral train and the other for elevation and depression. The gunner operates one with the right and the other with the left hand; with a little practice both movements can be made at one time, so that the gun is easily and quickly pointed.

In 1895 this gun was subjected to trial on the U. S. Army proving ground at Sandy Hook, and the following notes taken from the official report indicate its performance under the various tests included in the programme:—

The rapidity test consisted of firing 25 rounds. "The ammunition for this test consisted of twenty-one new and four old cases, three of which had already been fired three times and one twice. The four fired cases gave considerable trouble due to their imperfect condition. After making deduction for delays, caused by the sticking of these cases, the total time for the twenty-five rounds was 2 minutes and 34 seconds. The first twenty-one rounds were fired smoothly and without delays from the sticking of cases in exactly 2 minutes, and although the firing was conducted under adverse circumstances, due to the direction of the wind which blew the smoke into the faces of the gunners, this time may be considered as fairly representing the rapidity of the gun."

For the dust test: "The parts of the mechanism having been cleaned and lightly oiled, were subjected to a blast of pulverized sand for eight minutes. The breech-block was then opened without difficulty, sand and dust were removed from the mechanism by hand and from the chamber by a sponge; the gun was then loaded and fired" (five times); "the total time required was 1 minute and 15 seconds."

For excessive pressures: "The gun was fired five rounds with increasing pressures up to 47,000 pounds per square inch. The mechanism worked well through the test."

For the rust test: "For this test the gun was dismounted from its carriage and slung vertically from a gin. The parts of the mechanism were washed in a solution of soft lye and all traces of oil were removed; the parts were then assembled after being perfectly dried. The breech was immersed in a 15 per cent. solution of sal-ammoniac for 25 minutes, after which the gun was allowed to remain in a horizontal position for 48 hours, and was then replaced in its mount. The breech-block was then opened in 20 seconds, the guide-bolts and firing pin were oiled, the wooden plug which closed the chamber removed by a rammer from the front, a primed empty case inserted and breech-block closed. The total time to open the block, perform the above operations and fire the primer, was 41 seconds. Three service rounds were then fired without difficulty. The mechanism having been dismounted, all the parts were found well rusted."

Peculiar test: "As some doubt existed as to whether, under normal conditions, any portion of the pressure on the block could be transmitted to the main bolt, the latter was replaced by a wooden bolt of the same dimensions. The bearing surfaces on the block and jacket were well cleaned and dried, in order to utilize as much friction as possible. Two rounds were then fired with half and full charges respectively; the bearing surfaces were then thoroughly lubricated to diminish friction, and the two rounds were repeated—the wooden bolt was uninjured." The wood used was white pine.

Conclusion: "As a result of this test the Board is of the opinion that the 4-inch Driggs-Schroeder has shown itself to be a simple, safe and efficient mechanism for a rapid-fire gun of this caliber."

The range-table and other details are given at the end of this book.

5-Inch or 70-Pounder, and 6-Inch or 100-Pounder.

Both of these calibers of Driggs-Schroeder guns have been designed and can be manufactured at any time. The application of the system to guns of this size is desirable and practicable, as already shown in Chapter I.

Details of both designs are given in the tables at the end of this book.

Yacht Guns.

The two calibers of Driggs-Schroeder guns best adapted for yachts are the low-power 1-pounder and the 12-pounder landing gun (on ship mount).

The former was designed especially for this service, and is well suited to it on account of its light weight and of firing lighter charges than does the high-power 1-pounder, thus bringing much less shock upon its fastenings to the deck. In most private yachts of moderate tonnage this is an important consideration, as these vessels, not being primarily intended for carrying guns, the deck planking and beams are too light to stand the firing of heavy guns without producing leaks. It is not unlike the high-power gun in appearance, and the breech-mechanism is identical with and interchangeable with that of the high-power gun, Mark II. It is made, however, of a single forging (the charge being light), and the bore is shorter; the weight is only 88 pounds, including the trunnion-band which is screwed on. While furnishing an exact counterpart of all the main features of the naval gun, except as to range and penetration, it and its ammunition can be manufactured at a less cost.

The 12-pounders, while originally designed as landing guns, are admirably adapted to large steam yachts. Being mounted on the Company's recoil mounts, their recoil is not too severe for the scantling of these vessels, while from their caliber and actual size and style of mount, they present a fine, animated appearance, make a handsome salute or signal, and are very efficient weapons in case of need. They are furnished built-up or made of a single forging, as desired; the former has the higher power, and the latter is the less costly.

While it is highly desirable that crews of yachts should be familiar with the guns that they might be called upon to handle in case of war, the more immediately tangible advantages, perhaps, of a rapid-fire system in yachts lie in the use of metallic ammunition. The commendable features which attend its use are as follows:—In firing (whether for salute or with projectile) the gun is not sponged, and no premature discharge can take place, so that technical expertness is not necessary; the ammunition is much safer to carry and easier to stow than ordinary cartridge bags, and it requires little or no care to preserve it from fire or water.

Directions for the care and handling of these guns will be found in Chapter VI, and the range-tables and other details will be found at the end of the book.

CHAPTER IV.

Mounts.

The two general types of naval mounts for Driggs-Schroeder guns are known as non-recoil and recoil.

For the purpose of increasing the lateral train of guns mounted in a port, a sliding pivot mount is installed, by which the gun may be moved bodily to either side of the port to get more train in the other direction. The Y, or saddle, fits in a socket free to move on two clip-rails forming a slide secured to the ship's side; the motion is applied by a hand-wheel mitered to a traversing screw, the revolution of which pushes the sliding socket along.

Non-Recoil Mounts.

Non-recoil mounts consist of only two main parts, the pivot or saddle, and stand. The former is a single gun-metal casting, having the upper end forked like the letter Y and the lower end formed in a round stem which fits into the socket of the stand. The upper ends of the arms of the Y are fitted to receive the trunnions, which are secured in place by capsquares held down by screw-bolts.

In order to clamp the gun at any angle of elevation the bolt-heads have small sockets bored in them to receive the end of a small wrench, by means of which they may be screwed down hard and the capsquares forced down so as to bind the trunnions.

The crinoline stand which is generally used with mountings of this kind, is a single steel casting with eight legs, the base-ring, legs and socket all being in one piece.

Non-recoil mounts have the front end of the stock attached to the saddle or pivot and supported at the breech by the right guide-bolt. The end of this bolt, which is made longer than the left bolt, passes through an elongated hole in the bar, to allow the required play.

Driggs Hydraulic Recoil Mount.

The great advantage of recoil mounts in minimizing the shock of recoil is becoming so generally recognized that the practice now is to put all naval guns, even 1-pounders, on mounts of that description. When using them the shoulder-rest is attached wholly to the rocking slide, which has no linear movement with the gun.

The salient features of the Driggs recoil mount are compactness, simplicity, the arrangement which permits the recoil to be in the line of fire, and the construction which facilitates the fitting and assembling of parts and subsequent maintenance of adjustment.

In this system the trunnion-band has been dispensed with, the gun being screwed into a gun-metal casting termed the sleeve, the lower part of which projects downward and is fashioned into a socket as for a ball-and-socket joint. A single recoil-cylinder is placed in and embraced by this socket, a properly fashioned surface on the exterior of the cylinder forming the "ball" for the ball-and-socket joint, thus permitting a certain amount of movement in all directions. The object of this method of attachment is to prevent the piston-rod wearing an elongated hole in the front cylinder-head; with the cylinder and sleeve in one piece or rigidly connected, such wearing and consequent leaking of the cylinder would be apt to take place in consequence of the sliding gun-bed not being perfectly parallel to the axis of the cylinder, or of its wearing after being well fitted.

The cylinder contains the means for both checking the recoil and returning the gun to the firing position. The recoil is checked by regulating the flow of the liquid (glycerine and water) from one side of the piston to the other. This is accomplished by cutting longitudinal depressions or ports in the interior surface of the cylinder, the area of the cross-section of these ports varying in such a manner that, although the piston has a changing velocity, a constant pressure is maintained on the piston-head. The return to the firing position is effected by means of a counter-recoil spring in the front part of the cylinder, surrounding the piston-rod.

The sleeve is fitted to slide in and out upon steel-lined ways, forming a sliding gun-bed, on the gun-metal rocking slide or cradle, and the front end of the piston-rod is connected by a hinged joint to the breast-piece of this cradle. The cradle is fitted with trunnions which mount the whole system in the Y or pivot. The pivot, termed "saddle" in the U. S. Navy nomenclature, rests in the socket of the stand in the same manner as in the non-recoil mount. For the purpose of insuring ease of training, the ends of the pivots of the heavier guns rest upon hardened steel plates revolving on steel balls.

When the gun is fired the cylinder moves with the gun to the rear, bringing the ports to the edge of the piston. As the rearward movement continues the piston travels over the ports, permitting the liquid to pass from the front to the rear face of the piston. The ports are so cut that while the velocity of the cylinder is the greatest the flow of liquid is the freest; for the first part of the motion the size of the ports rapidly increases, and from the maximum point decreases gradually until the desired amount of recoil has been reached, when the ports end. At this point the spring, which has been compressed by the recoil, returns the gun to battery.

A cage-stand is generally used, but the type varies with the conditions under which the gun is employed.

If necessary, to accommodate the gun to the arrangement of the battery and the design of the ship, mounts having special fixtures are provided. In all cases, however, the recoil mechanism is the same, the design of the rest of the mount being varied to meet the requirements of the gun's emplacement.

The pistol-grip is placed on the bar of the shoulder-rest, the trigger being connected with the sear by a wire cable laniard.

A training clamp is fitted through the stand to clamp the pivot against lateral train; and an elevating clamp through the saddle clamps the cradle against vertical train.

Rail Mount.

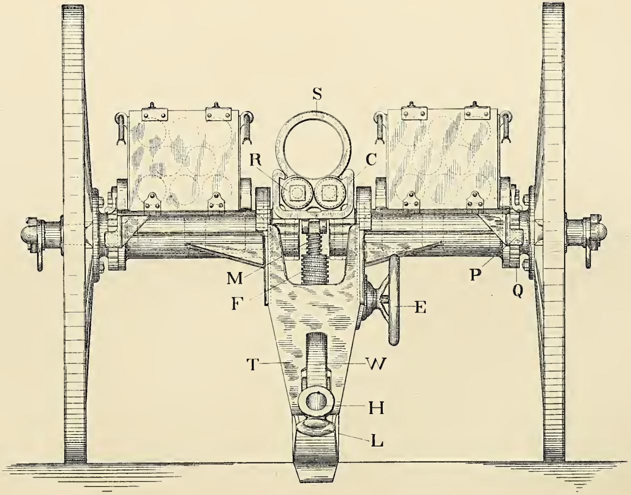
With this description of mount the pivot fits in a socket bolted in the rail of the ship.

Top Mount.

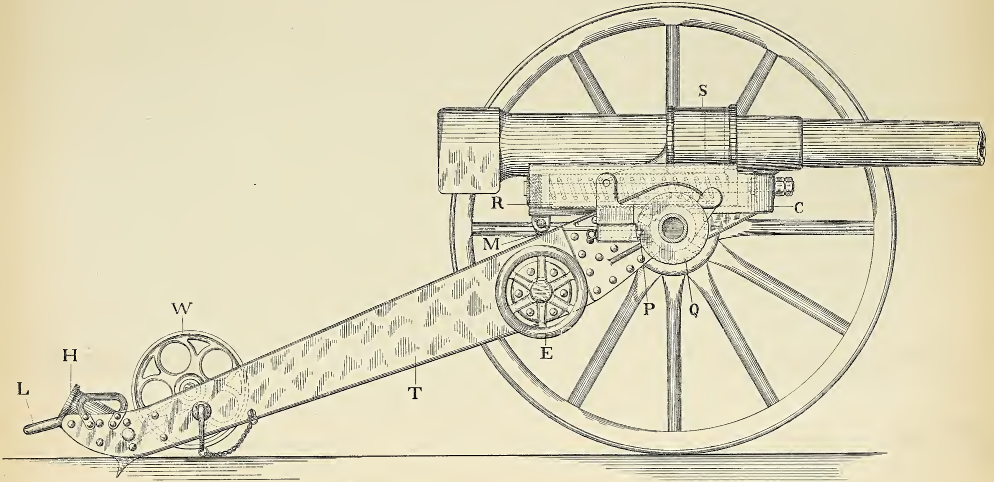
In this design the recoil mount is secured to a traversing carriage which travels on a rail bolted inside the top-rim.

DRIGGS MINIMUM RECOIL FIELD AND LANDING CARRIAGE.

MODEL OF 1893.



REAR VIEW.



SIDE VIEW.

Driggs Minimum-Recoil Landing Carriage.

MARK I (MODEL OF 1893).

In designing this carriage, the first object in view was to eliminate *jump*, which is so fatal to accuracy of fire; and it was recognized that this would be effected more or less completely if the recoil over the ground could be delayed until the shell should be clear of the muzzle. This can only be accomplished by allowing the gun a certain amount of recoil within the carriage, independent of and previous to the motion of the latter.

To this end the gun is screwed into a bronze casting, termed the recoil-sleeve (S, Plate XI), which comprises two hydraulic recoil-cylinders, R, in its lower part. This sleeve, carrying the gun, slides back and forth on steel-lined ways, termed the gun-bed, fashioned in another casting termed the cradle, C. The cradle rests directly upon, and pivots upon the main axle, being held securely on by inverted capsquares screw-bolted on underneath. The front ends of the piston-rods of the recoil-cylinders attach to the breast-piece of the cradle. The ports for the restricted passage of the liquid are cut in the interior face of the cylinders; their total cross-sectional area is constant for 3½ inches for the 12-pounder, and sufficiently large to produce only a slight check through that distance, at the end of which time the shell will have left the bore; from that time the areas decrease to zero at a total distance of eight inches. It has been found in practice that the total recoil in the gun-bed is less than this. A counter-recoil spring, which incidentally also helps to check the recoil, is placed in each cylinder, in front of the piston, surrounding the piston-rod; at the end of the recoil it pushes the sleeve and gun frontward into the usual or firing position.

A spade is fashioned under the shoe at the rear end of the trail, which, by digging into the ground will check the rearward movement of the carriage. In soil of favorable character the spade stops all recoil completely, but when the ground is frozen or of rocky or otherwise unfavorable character it is of little avail. To provide for this contingency the wheels are locked; ratchet-teeth, Q, are cut on the circumference of the inner part of each wheel-hub, in such manner that a spring-pawl, P, housed in the carriage frame will engage them and prevent the wheel turning for movement to the rear (in firing), but allows perfectly free movement to the front. On limbering up for the march, the pawls are withdrawn out of action, leaving the wheels free.

The elevating gear comprises a vertical male screw, M, which is attached by a hinge-bolt at its upper end to the cradle, and works in the female thread of the nut, F, which is also threaded on the outside for action in the screw-box of the trail; feathered upon the lower end of the nut is a travelling collar which gears into miter-wheels on a short horizontal shaft which projects to the right side beyond the trail-bracket and terminates in a hand-wheel, E. The gun-pointer turns this wheel by hand; through the miter-wheels the shaft turns the travelling collar which in turn causes the nut to turn, and, by the action of the screw-box, to also move up (or down); this movement causes the male screw also to move up (or down), thus doubling the amount of movement. The motion of the male screw is communicated through the cradle to the gun-breech, elevating or depressing the gun.

A socket, H, is formed in the shoe of the rear end of the trail to take the handspike used in giving the gun lateral train. A trail-wheel, W, is also fitted there, easily disconnected for firing; also an eye or lunette, L, for hooking it up to the limber if the latter be employed.

Two ammunition-boxes are carried on the carriage-frame, one on each side of the gun.

The numerical data of the 12-pounder carriage are as follows:

Total weight, without ammunition boxes, . . .	750 lbs.
Weight of one ammunition-box, empty, . . .	45 "
" " " full, . . .	173 "
Number of rounds carried	16
Size of ammunition-box, ...	19.9 x 11 x 10 ins.
Weight of each wheel, ...	96 lbs.
Diameter of "	44 ins.
Tread of "	2.75 "
Width of track, ...	49.9 "
Length over all, ...	76.25 "
Width "	58 "
Vertical sweep of fire, ...	25°

With regard to the part played by this carriage in the matters of accuracy and rapidity of fire, it has been observed during extensive firings on the American Ordnance Company's proving ground, that the jump is slight and is *constant*; also the recoil over the ground is zero to 2½ feet, depending upon the condition of the soil. With small and constant jump, the practice is naturally good, and with so little recoil it is evident that great rapidity of fire can be maintained.

Limber for 12-Pounder Driggs-Schroeder Landing Gun.

For service of such nature as to call for more ammunition than is contained in the boxes on the 12-pounder landing carriage, a two-wheel limber is provided, holding 58 rounds. This consists of a stout steel chest strongly riveted to the three bearings on the axle. The cartridges are stowed flat, heads of cases to the rear; the rear side of the chest is hinged at the bottom and opens down, forming a convenient shelf to handle the ammunition upon. The top of the chest forms a seat for two men, a foot-rest being fashioned in front. A pole and whiffle-trees are fitted to permit of draught by horses or mules if desired. A pintle-hook is formed on the rear side of the frame to take the lunette in the trail of the gun carriage.

The numerical data are as follows:

Length over all, including pole,	14 ft. 02 ins.
Width over all,	58 "
Diameter of wheel,	44 "
Tread "	2.75 "
Width of track	49.9 "
Number of rounds carried,	58

Driggs Minimum-Recoil Field and Landing Carriage.

MARK II (MODEL OF 1895).

This carriage differs from the Model of 1893 in that means are provided for giving lateral train independent of that obtained by swinging the trail, and that in the construction the frame is carried up and forms the bed for the gun, taking the place of the old cradle, saving weight and reducing the number of parts.

The recoil-sleeve, instead of having the gun screwed into it, forms in its upper part a socket, as for a ball and socket joint, the ball part of the combination being formed by a suitably shaped spherical casting screwed on the gun in place of the trunnion-band or sleeve. For purposes of construction and assemblage the socket is in two parts, the upper part being hinge-bolted to the lower. The size of the ball surface and the shape of the socket are such as to permit

15° of elevation and 10° of depression. The lateral train is limited by the travel allowed to the breech end of the gun, and is 4° on each side, 8° in all. A stud-bolt projecting through the socket into a longitudinal groove in the ball prevents the gun from revolving on its axis.

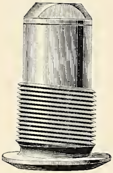
As for both vertical and lateral train the gun oscillates in the socket of the recoil-sleeve, the recoil is not always directly in the line of fire, parallel to the gun-bed, and therefore the elevating and training gear has to move with the gun in recoil, and must therefore be connected with a moving part, and not with the trail as in the Mark I. To this end, the rear part of the recoil sleeve, which rests and slides directly on the carriage-frame, is extended to the rear and downward, forming a sliding way upon which a sliding pivot holding the lower end of the elevating screw rests and travels; the side-bracket of this extension forms, on the right side, a point of support for the training screw to act in.

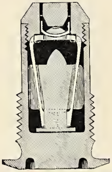
The operation of the elevating gear is the same as in the Mark I, except that the upper end is connected to a plate tap-screwed to the gun-breech itself. To effect lateral train, a hollow translating shaft, with large hand-wheel, is placed on (around) the horizontal shaft of the elevating hand-wheel; a thread cut on the outer surface of this hollow shaft engages the nut formed in the side bracket of the recoil-sleeve, and its inner end is connected with the sliding pivot of the elevating screw; on being turned by means of the hand-wheel, this shaft moves in or out through the side bracket, moving the sliding pivot and with it the gun. The two wheels, for lateral and vertical train, turn on the same axis, the larger one giving lateral train, and the smaller one vertical train.

The recoil of the gun within the carriage, and that of the carriage over the ground are checked in the same manner as in the Model of 1893, viz.: by the recoil-cylinders, and by the pawls and ratchets for locking the wheels and the spade at the end of the trail. If intended for a field-carriage, there is no trail-wheel, as this mounting is not intended for use except in company with a limber, and no ammunition is carried. If for a landing gun, such as the 12-pounder or 1-pounder, the trail-wheel is fitted, and a box-rest constructed on each side of the gun for ammunition-boxes. A tool-box is fashioned within the trail.

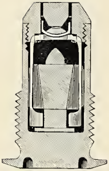
PLATE XIII.

DRIGGS PERCUSSION FUZE.

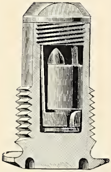


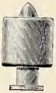


Position of Spring before and during firing.

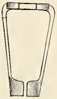


Position of Spring during flight.





Plunger.



Spring.

CHAPTER V.

AMMUNITION.

The Driggs Percussion Fuse.

The fuse used with all ammunition other than shrapnel, issued by the American Ordnance Co., is the Driggs Percussion Fuse, usually constructed for application as a base fuse. With shrapnel a time fuse is used.

In the Driggs Percussion Fuse, shown in Plate XII, safety in handling is obtained in an entirely novel and effective manner. Owing to the mechanical principle involved in its construction it can only be made operative, or armed, by imparting to it a high velocity of rotation such as that derived from the rifling of the gun.

The parts of the fuse are the body, the plunger or pellet, the spring, and the detonating cap.

The body is of gun-metal, the rear end having a broad, thin flange which serves as a gas-check. Forward of this a thread is cut for screwing into the projectile. The plunger is also of gun-metal, and at its rear end has a circular score to receive the two lugs of the spring; the front end is provided with a blunt point for exploding the cap upon impact. The spring is of tempered steel, and is bent so as to form two arms having at their lower ends circular lugs.

The detonating cap consists of a hollow brass cap filled with fulminate of mercury, and is contained in the screw-cap which screws in in front of the spring and plunger.

The parts are so assembled that the rear end of the plunger normally rests upon the interior bottom of the body. The two circular lugs of the spring fit in the score of the plunger, pressing into it with a strength that can only be overcome by the centrifugal force produced by a high velocity of rotation. When the gun is fired the rotation given to the shell by the rifling causes the arms and lugs of the spring to open out away from the center sufficiently to release the plunger, thus arming the fuse. Upon impact the plunger goes forward and explodes the cap, the flame from which passes through two vent-holes in the top of the fuse and into the shell.

Numerous government tests have been shown that this fuse is safe, certain of action, and of great accuracy as to the time of explosion after impact. The official report on a comparative test of this and another fuse, in 1890, stated "With ordinary rough handling both are secure, and for exceptionally rough handling the Driggs possesses the advantage."

The point at which explosion occurs depends upon the retardation of the velocity, and varies from a few inches, when fired through a heavy armor plate, to six feet when fired through a two-inch oak plank. On official test, in which seven Driggs fuzes were fired from a 3-pounder for regularity of bursting, the extreme variation was two feet; the velocity of the projectile was over 2,000 f. s.; the bursting plank was two-inch oak; the points at which the explosion occurred varied between four and six feet in rear of the bursting plank. The great uniformity as to the point of explosion is due to two causes; one is the accuracy of manufacture, and the other the use of a solid plunger. In fuses having the firing point held in the plunger by friction, or the plunger in two parts held together by friction, there must be a variation in the support of the firing point, and consequently a variation in the force of impact and explosion.

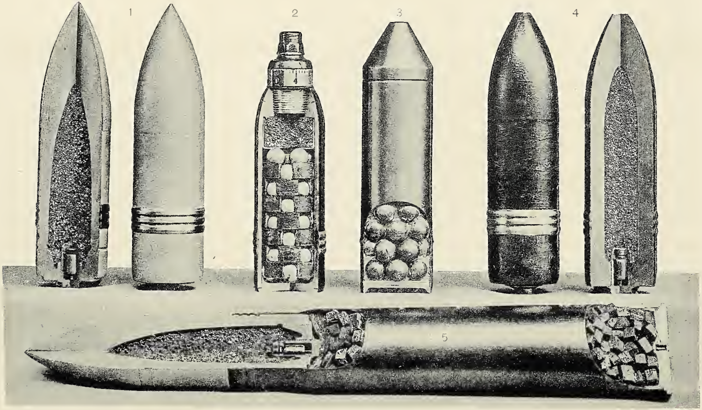
Driggs Mortar Fuse.

For use in shell having a very low velocity, such as those thrown from mortars, the Driggs Mortar Fuse has been produced, in which less centrifugal force is required to arm than in the percussion fuse. In this design the external shape and the methods of insertion and ignition are the same as in the percussion, but in place of the spring, a number of small steel balls are placed in a cannelure in the fuse body around the cavity for the plunger; ordinarily, in any position in which the shell may lie, some of the balls rest against the plunger, partly in a shallow groove cut around it and partly in the cannelure, and thus prevent any motion; but when the shell is discharged from the mortar, the centrifugal force created by the spin, due to the rifling, causes all the balls to recede instantly to the bottom of the cannelure, leaving the plunger free.

Cartridge Cases.

All the cases used with Driggs-Schroeder ammunition are solid-drawn. The first cases of this kind for rapid-fire guns built in the United States were furnished by the Driggs Ordnance Company and supplied to the U. S. Army.

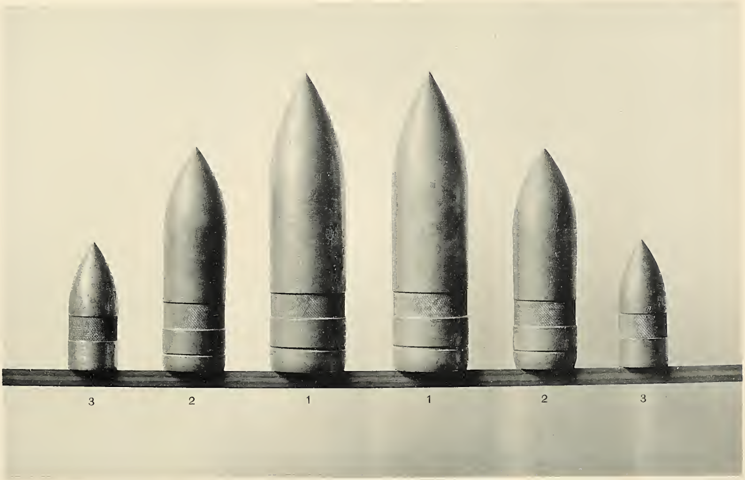
PLATE XIV.



ASSEMBLED AMMUNITION.

1. STEEL SHELL. 2. SHRAPNEL. 3. CASE SHOT 4 COMMON SHELL. 5. COMPLETE CARTRIDGE.

PLATE XV.



PROJECTILES AFTER PERFORATION OF IRON PLATES.

1 6-POUNDER SHELL, 4-INCH PLATE. 2. 3-POUNDER SHELL, 3-INCH PLATE. 3. 1-POUNDER SHELL, 1-INCH PLATE.

The superiority of the solid-drawn case has been demonstrated beyond all question, the built-up being now out of use in the United States. All sizes are manufactured, from the short 1-pounder case to the five-inch; and six-inch will be furnished as soon as called for. The ignition is effected by a detonating cap, which is the same for all calibers. With field ammunition, which may be subjected to violent jolting over rough ground, a safety-cap is used to prevent any possible jar from igniting the fulminate cap and exploding the charge.

Shell.

Both armor-piercing and common shell are supplied for Driggs-Schroeder guns of all calibers. For the former a process of tempering has been developed at the Company's proving ground by which an extraordinary resistance to deformation has been obtained; this is illustrated in Plate XIV. The patented method of knurling the band-seat has also proved most successful in application, causing the band to grip well and resulting in less weakness and injury to the shell than is usually caused. With all shell, both common and armor-piercing, a copper rotating band is used. Copper is regarded by the American Ordnance Company as much superior to brass for this purpose, as it is softer and therefore a more perfect gas-sealing metal, while it is hard enough to prevent stripping. It also has the advantage of uniformity, while brass, being an alloy, is found in the market of all degrees of strength and hardness, and does not offer a uniform resistance to being forced into and through the grooves, bringing different strains on the gun and different velocities to the projectile. A special test was carried on at the U. S. Navy proving ground in 1890 to determine if the difference in rotating bands had any appreciable influence upon the velocity, as claimed by the American Company. Ten shell, five copper-banded and furnished by this company and five with brass bands and furnished by another company, were carefully loaded to exactly the same weight, and the powder charges were measured with equal care. According to the official report the average velocity of the copper-banded shell was 5 f. s. greater than the average velocity of the others, from that cause alone.

Shrapnel.

The shrapnel designed for issue with Driggs-Schroeder guns is of simple design, easily understood from the figure in Plate XV. The body is of cast

L. of C.

iron, and the individual iron discs with which it is filled are sectioned radially to determine the fractures on explosion. The bursting charge is placed in the head and in a smaller communicating axial channel.

It will be noticed that this construction combines great strength opposed to the shock of discharge, and slight resistance to rupture by the bursting charge.

A 12-pounder shrapnel of this design furnishes, by actual count, 200 pieces.

Cannister.

The cannister consists simply of a drawn brass case, containing lead balls packed in sawdust, the number of balls depending upon the caliber. Near the rear end is a shoulder to take against the edge of the cartridge case and prevent the can from entering too far. No means is provided for making the cannister take the rifling.

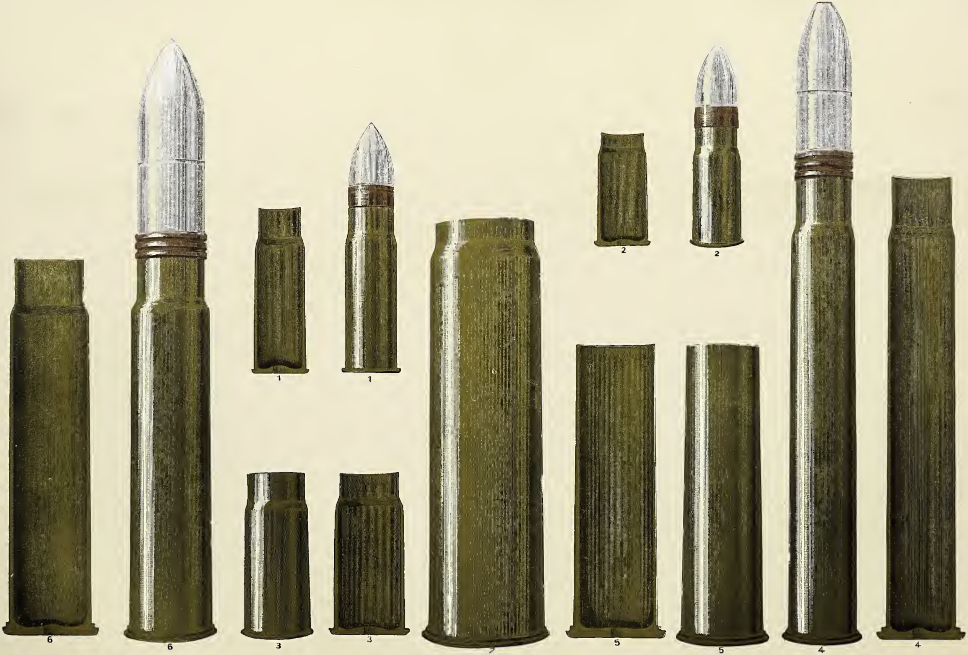
The use of cannister in rifled guns other than of the smallest calibers, is not recommended by the American Ordnance Company.

Drill-Cartridge.

For purposes of drill and practice in loading, drill-cartridges are provided for Driggs-Schroeder guns of all calibers; they are shaped exactly as the assembled cartridge-case and projectile, to fit the chamber. Furthermore, a section of musket barrel is secured axially in the drill-cartridge, so that sub-caliber target practice may be had by firing bullets, the ordinary musket cartridge being inserted in the barrel and the mechanism of the gun employed to fire just as if full-caliber charges were used. In this way very cheap, and at the same time very useful target practice may be combined with the drill, the limited range of the musket cartridge making it especially desirable where restricted waters or grounds may render it dangerous to fire the regular charges and projectiles.

The drill-cartridge is made of an ordinary cartridge case reinforced by an interior wood disc, and having the front end finished to shape by a hard wood plug with bronze cap; the whole is bound together and strengthened by the interior musket barrel. See Plate XVII. A small leaf-spring is fitted in a recess at the rear end, having a lip for holding the musket cartridge-case in; by forcing the spring out with the thumb nail or any small instrument, the case is easily extracted.

PLATE XVI.



AMMUNITION.

1.—1-pounder Cartridge and Cartridge Case. 2.—1-pounder (low-powered) Cartridge and Cartridge Case. 3.—47 mm. Cartridge Case. 4.—3-pounder Cartridge and Cartridge Case. 5.—Cartridge Case for 6-pounder Field Gun. 6.—6-pounder Cartridge and Cartridge Case. 7.—Cartridge Case for 3.2-inch Field Gun.

After each shot the drill-cartridge is ejected from the gun by opening the breech as usual and another one put in. The little empty sub-caliber cases are afterwards extracted from the drill-cartridges, and new ones put in as often as may be required.

Recapping and Reforming Tools.

The functions of the recapping and reforming tools are easily understood from the drawings, Plate XVII.

To recap a fired cartridge-case, place the head in the capping block, as in the drawing; enter the decapping punch and force out the cap with a few blows of a lead or copper hammer. The ring in the end of the punch limits its travel to the amount necessary to completely decap.

To recap, place the mouth end of the case in the other end of the capping block; insert the cap and press it home by the short capping rod, using a copper hammer if necessary.

Cartridge-cases can generally be used over a good many times, but in course of time they become deformed by firing and must be reformed. The tool for doing this consists of a steel-cast reforming cylinder reamed to exactly represent the chamber of the gun; this cylinder has trunnions by which it is conveniently suspened in the frame, and can be tilted to insert or remove the cartridge case. The case, having been decapped, should be thoroughly cleaned and oiled on the outside, and the cylinder should likewise be carefully cleaned inside. The case is then inserted in the cylinder and forced home by the screw. The cylinder is then inverted on its trunnions and the case backed out.

CHAPTER VI.

Drill and General Instructions.

The following drill is provided for Driggs-Schroeder guns of the secondary battery in all calibers up to and including 14-pounders. The same drill should be used for field guns so far as it applies, the handling of the carriage and limber being carried on in conformity with the standard drills of the Naval or Army services.

A gun's crew consists of three men, stationed as follows:

Nos.	Stations.	Arms, revolvers.
1	1st Captain	1
2	2d Captain	1
3	Shellman	1

The stations of the crew for mustering, when the gun is secured are as follows: For guns mounted on deck—in line, directly in rear of the gun, facing inboard, No. 1 on the right; for guns mounted aloft—on deck, abreast the mast, facing outboard, No. 1 on the right.

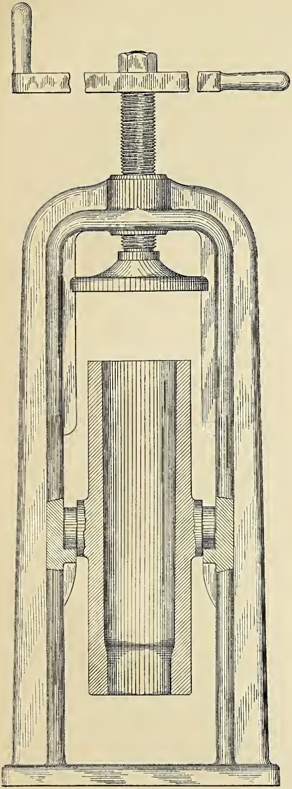
The exercise supposes the guns to be mounted in place and lashed as well as clamped against elevation and train.

Words of Command.

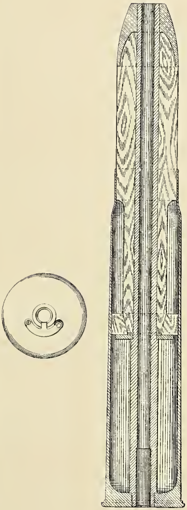
I. Silence ! Cast loose and provide !
II. Load !
III. Point !
IV. Commence firing !
V. Cease firing !
VI. Unload !
VII. Secure.

PLATE XVII.

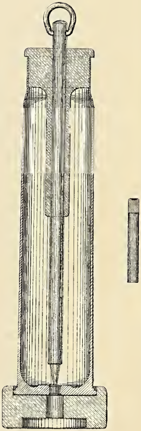
DRILL CARTRIDGE AND RELOADING TOOLS.



REFORMING TOOL.



DRILL CARTRIDGE.



RECAPPING TOOLS.

I.—SILENCE.

This is preparatory, and is given to secure attention to the following order :

CAST LOOSE AND PROVIDE.

1 commands; removes gun cover; casts adrift gun lashings ; places sight cover clear; ships gun stock, if unshipped; tests breech mechanism; examines bore; sees in place gear and implements for the service of the gun; takes off drill washer if powder is to be used.* When all is ready, reports to the officer in charge and takes station in rear of and facing the gun.

If gun is mounted aloft, he first goes aloft and sends down tackle for hoisting up ammunition and other articles for the service of the gun; receives articles whipped up by 2 and 3.

2 provides and examines the reserve box containing the accessories and spare parts; † provides three revolvers and belts, and puts revolvers in rack near the gun; provides clean swab; adjusts drill apron, if they are furnished and if the exercise is to be without powder; ‡ sees elevating and training clamps in working order; sees carriage in working order; takes station at left side of breech and facing it. If the gun is mounted aloft, he does not go aloft until all the articles for the service of the gun have been whipped up; then secures net to top under the lubber's hole.

3 provides swab and bucket of water; brings ammunition from hatchway, and places it in rear of gun amidships; § takes station alongside the ammunition. If gun is mounted aloft, assists No. 2.

After performing the above duties, each man will put on his belt and revolver. It is recommended that except in case of actual battle, the division officer, after inspecting the accoutrements and arms, shall give the order "*Lay aside belts and arms*"; at this order the belts and revolvers will be removed from the person and placed clear of the gun and ammunition.

II.—LOAD.

1 places right shoulder to stock; siezes directing handle with left hand, and as soon as the gun is unclamped, lays it with the muzzle outboard; plants feet firmly to resist motion of the ship.

2 assists 1; unclamps the elevating and training clamps as soon as 1 has his shoulder to the stock; grasps operating lever with the left hand and throws it

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* Note 8. † Note 12. ‡ Note 9. § Note 1.

back smartly, opening breech; takes cartridge from 3, points the shell fairly, and then enters it smartly with the right hand, and closes breech with the left.* Performs duties of 3 while the latter is providing fresh box of ammunition.

3 passes cartridges to 2.

III.—POINT.

1 steadies the gun with the right shoulder and left hand; adjusts the sight with the right hand, then seizes pistol-grip, finger on trigger, and with his eye ranging over the sights, steadies the piece upon the target.

2 sees elevating and training clamps loosened; at a sliding pivot mount, adjusts the position of pivot for train.

IV.—COMMENCE FIRING.

1 tends sight, rectifies aim and fires;† after reloading again rectifies aim and fires, and so on.

2 tends clamp and loads.‡

3 supplies ammunition to 2, and in long continued rapid firing stands by to relieve him; keeps empty cases clear of gun; when ammunition is nearly exhausted, provides a fresh supply.

V.—CEASE FIRING.

1 removes his hand from pistol-grip, and steadies the gun until the elevating and training clamps are tightened.

2 tightens elevating and training clamps.

VI.—UNLOAD.

2 grasps operating lever and draws it back *easily* with left hand, keeping right hand in rear of breech opening; removes cartridge;§ passes it to 3; sponges bore if necessary; closes breech.

1 cleans and lubricates mechanism, if necessary, assisted by 2; then, when breech is closed, puts on drill-washer, and uncocks.

3 receives cartridge from 2, replaces it in box, then closes box.

VII.—SECURE.

The numbers return what they provided, and secure what they cast loose, the gun having first been laid to the securing position.

* Notes 2 and 4. † Note 7. ‡ Notes 2, 3, 4, 6 and 7. § Note 5.

Directions for Dismounting the Mechanism.

2 clamps the gun.

The breech being closed, 1 full-cocks and holds the block with the combination hook and wrench; with the larger calibers, sustains the block additionally with the left hand underneath. 2 takes off operating handle and spring lock; taps the main bolt gently to start it. 3 withdraws main bolt. 1 allows block to descend far enough to clear the grooves, then pulls it straight away to the rear, and places it on its side. 2 takes out sear-spring (1 holding sear up as a precaution), takes off face plate.* 1 turns block face down on a wood surface, takes off combination hook and wrench, snaps firing pin by pressing down and removing sear, lifts the block, leaving the cam, firing pin and firing spring to drop out.† 2 removes extractors and sights. 3 takes off tray and shoulder-stock if desired.

[In Mark I of 3- and 6-pounders, the guide-grooves not being run out at the front face of the breech block, 2 backs out left guide bolt far enough to clear the guide grooves, before taking off handle. 3 backs out right guide bolt in the same way. 1 uses the finger catch to full-cock and afterwards to uncock, and then takes off finger catch, takes out sear plug, sear spring and sear. 3 takes out face plate locking screw and face plate, and firing pin and spring and cam.]

Except in rare instances, such as in dismounting for transportation or cleaning, the sights should not be removed.

Directions for Mounting the Mechanism.

Each man performs, in reverse way, the duties assigned him for dismounting. 1 must be careful to full-cock before 2 attempts to put on the face plate, and should hold the sear up engaging the cock-stud during that operation.

Detail Notes Upon the Exercise of Driggs-Schroeder Guns.

1. During action the ammunition supply for rapid-fire guns is dependent mostly upon the rapidity with which it can be whipped from below. It would be impossible to supply it as fast as it could be used in continuous rapid firing. It will, therefore, be necessary to take advantage of all interruptions of fire to increase the supply at the guns; with a given whipping capacity, the carrying from the scuttles to the guns depends upon the distance and accessibility. One man, called the Supplyman, assisted by No. 3 of each gun, can probably supply

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* Note 10.

† Note 11.

ammunition to four guns (two on a side) as fast as it is received from below. There should, therefore, be a Supplyman detailed for every four guns of the secondary battery. With Driggs-Schroeder 6-pounder guns, Nos. 1 and 2 can fire 12 to 15 shots a minute with No. 3 away.

2. In inserting the cartridge, 2 will keep it in mind to hold the rear end slightly raised with reference to the point, so as to avoid driving the point of the shell against the upper edge of the chamber. The lower edge and the sides are protected respectively by the breech-block and extractors.

Neglect to observe this precaution may result in a burr about the upper edge of the chamber.

While it is not necessary that the case should be pushed home against the extractors, it will be safer to send it well home. The extractors have a certain amount of yielding that will accommodate itself to any severity of ramming within reasonable limits.

3. If, after firing, the cartridge-case sticks after partial extraction, fully extract and then look for dirt or caked powder in the chamber. If such exists it must be removed with a sponge if there is time.

4. If, in loading, a cartridge jams and will not let the breech-block close, never attempt to drive it home by forcing the block; unload at once, put the cartridge aside and try another. This is not apt to happen except with old cases not properly reformed.

5. If the cartridge does not extract, ram it out from the muzzle.

6. Should one extractor break through undue stress from a sticky cartridge-case, the other will continue to extract satisfactorily; but the first opportunity should be taken to put in a new one: full-cock, withdraw main bolt, pull block straight away to the rear, remove broken extractor and put in new one, replace block and bolt. Do not put in the new extractor with a cartridge already in the gun as the nib will come on the wrong side of the cartridge-head.

7. If the primer misses fire, the breech should not be opened immediately, as it might be only a hang fire, in which case a serious casualty might result. Utilize the desired delay in full-cocking without opening the breech and firing again; note, while retracting the firing pin, if the tension of the spring seems sufficient, for if it does not it will indicate that the spring is defective. If it feels stiff enough, but misses fire the second time, open the breech, extract, put in a new cartridge and fire once more. If it still misses, dismount the block, remove the face-plate, and renew the firing point or spring, whichever is found defective.

If the cap should have failed to obturate at any shot, it is possible that a residuum may have been deposited on the front end of the firing pin or rear face of the face-plate, which might shorten the throw of the former and prevent it striking the cap; if this is the case it should be immediately wiped off.

8. The drill-washers are designed to prevent the firing pin from delivering a sharp blow on the face-plate when snapping the gun at drill. Although they slightly compress the firing spring when on, it is found that the spring does not suffer permanent compression, and it is best to keep the washer on at all times except when actually engaged in battle or exercise with powder.

9. Drill-aprons are used only when the exercise is with drill-cartridges, to catch them when ejected from the breech and prevent their falling on and denting the deck. They are not particularly convenient, and it is usually found practicable to protect the deck with swabs. They are not furnished unless specially called for.

10. Be sure to keep the firing pin cocked while taking off the face-plate; otherwise the firing point will be bent or broken by the plate.

11. If there is no wood service convenient for snapping the firing-pin into, hold it back with the wrench and ease it forward on removing the sear; if allowed to fly, it would do so with some force and possibly be lost.

12. The reserve boxes contain the following accessories and spare parts:

Accessories—Hand extractor, screw-driver, combination hook and wrench, babbitt metal mallet, oil can, drill-washer support, drill-washers, cleaning brush, sponge-brush and rod.

Spare parts—Firing pin, firing points, firing springs, right and left extractors, sear, sear-spring.

Care and Preservation of Guns and Mounts.

It is essential that rapid-fire guns and their mounts should be kept clean in all their parts, properly lubricated and in thoroughly good working order. The frequency of inspection and cleaning will depend upon the weather, the skill of the crew and other circumstances; there is no part of the Driggs-Schroeder mechanism which is easily injured, although of course care should be exercised not to dent the surfaces or the deck by dropping the parts. When the crew has become fairly expert, the mechanism should be dismounted and cleaned and lubricated at least once a week in fair weather and more often in damp or wet weather.

Vaseline is the best material for lubricating; or failing that, fish oil is the next best. The use of lard oil is injurious, and in cold weather it forms a stiff wax which will prevent the gun working properly until it has warmed up enough to soften the oil. Lard oil should more especially never be used on the firing pin or spring.

No emery should be allowed near the gun; if needed it should be applied only by trained men under special directions.

To preserve the bronzing: The gun should not be wiped off during rainy weather. After the weather has cleared let the gun dry before doing anything to it; rust spots may then show on the outside; if so, rub the gun over (when entirely dry) with a file card, which will remove the rust and restore the surface of the browning; then oil the piece, without heavy rubbing, and it will look the same as originally.

When rainy or damp weather is likely to last for a long time and the gun not in use, the sight-bar and front sight (not the sight-boxes) should be taken out, the mechanism dismounted, and all put under cover, while the bore should be plugged at both ends.

After every firing, the gun should be carefully washed out with fresh water; if a hose is available it will be found very efficient; point the gun over the ship's side and depress the muzzle. Afterwards dry the bore thoroughly and oil it with a rag over the bristle sponge. Particular attention should be given to keeping the band-slope and the origin of rifling well oiled and free from rust.

The non-freezing liquid in the recoil-cylinders (glycerine about 80 per cent. and fresh water about 20 per cent.) is found to become muddy after a certain time, and the grooves become clogged from the deposit of a thick pasty sediment, which is removed with considerable difficulty. It is therefore advisable to empty, clean and refill the cylinders at least once in every two months, as much fresh liquid being added as may be necessary.

As the recoil-cylinders occasionally leak, special attention should be given to that point, and if any leakage be discovered the loss should be made good. It is a wise precaution to examine them before every firing, with this special possibility in view.

Tables.

The following range-tables have been computed by Ingersoll's formulae and ballistic tables. The value of i has been taken as follows:

For ogival of	1	caliber radius,	1.0527
"	1½	"	1.03
"	2	"	1.00
"	2¼	"	.985
"	2½	"	.9677

The perforation of steel is for plain unbacked steel without surface hardening, and supposes the projectile to be undeformable. It has been computed by De Marre's formula, modified by the results of firing against steel plates on the proving ground, which show that with ogivals of more than two calibers radius the velocity must be increased in the equation. The formula, reduced to English units, is

$$V = \frac{a^{.75} e^{.7}}{p^{.5}} [\,(\log)\, 3.00.945].$$

The perforation of steel actually obtained with Driggs-Schroeder shell at 50 feet from the muzzle is 4.25 inches, which requires that one-eighth be added to the velocity in order to satisfy the equation. The perforation of wrought iron may be obtained very closely by multiplying the perforation of steel by 1.4.

Range Table for Driggs-Schroeder 1-pdr. L. P. Gun.
33-Caliber bore.

Diameter of Projectile....................1″.445
Weight " " ....1.06 lbs.
Length " " ....2.5 cals.
Radius " Ogival......... ....2.25 "

Initial Velocity (Black Powder).........1460 f. s.
Permanent Angle of Sight Bar................2°
Sight Radius...........................26.″4
Angle of Jump..............................0°

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Angle of Fall.	Remaining Velocity.	Time of Flight.	Dangerous Space for Objects 6 Feet High.	Perforation of Steel.
Yards.	Ins.	° ′	° ′	F. S.	Secs.	Yards.	Ins.
0	—	—	—	—	—	All the range.	1.26
100	0.063	0–08.2	0–09	1351	0.21		
200	.133	17.2	19	1255	.44		1.08
300	.210	27.7	31	1175	.69		
400	.294	38.3	45	1110	.95		0.95
500	.386	50.1	1–01	1057	1.23		
600	.487	1–03.3	1–19	1015	1.52	103	0.87
700	.593	1–17.2	1–39	979	1.82	76	
800	.707	1–32.0	2–01	946	2.13	60	0.81
900	.827	1–47.5	2–24	915	2.45	48	
1000	.953	2–03.9	2–49	887	2.79	40	0.76
1100	1.086	2–21.2	3–15	861	3.14	34	
1200	1.226	2–39.4	3–43	836	3.49	30	
1300	1.373	2–58.5	4–13	812	3.85	27	
1400	1.527	3–18.5	4–45	790	4.23	25	
1500	1.689	3–39.5	5–20	769	4.62	23	0.66
1600	1.859	4–01.5	5–57	748	5.02	21	
1700	2.037	4–24.5	6–37	728	5.43		
1800	2.223	4–48.5	7–19	709	5.84		
1900	2.418	5–13.6	8–04	691	6.27		
2000	2.621	5–40.0	8–53	673	6.71		
2100	2.834	6–07.5	9–46	656	7.16	Dangerous space is given for further end of range only.	
2200	3.057	6–36.1	10–42	639	7.63		
2300	3.290	7–05.9	11–43	623	8.11		
2400	3.533	7–37.1	12–48	608	8.61		
2500	3.788	8–09.6	13–59	594	9.12		
2600	4.056	8–43.8	15–17	580	9.64		
2700	4.341	9–20.0	16–42	567	10.18		
2800	4.643	9–58.3	18–14	555	10.73		
2900	4.962	10–38.7	19–58	544	11.30		
3000	5.298	11–21.3	21–57	535	11.88		0.46

Range Table for Driggs-Schroeder 1-pdr. H. P. Gun. (Mark II.)

Diameter of Projectile	1″.445	Initial Velocity (Black Powder)	1884 f. s.
Weight " "	1.06 lbs.	Permanent Angle of Sight Bar	2°
Length " "	2.5 cals.	Sight Radius	28″.436
Radius " Ogival	2.25 ,,	Angle of Jump	0°

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Angle of Fall.	Remaining Velocity.	Time of Flight.	Dangerous Space for Objects 6 Feet High.	Perforation of Steel.
Yards.	Ins.	° ′	° ′	F. S.	Secs.	Yards.	Ins.
0	—	—	—	—	—		1.99
100	0.041	0–04.9	0–05	1743	0.16	All the range.	
200	.087	10.5	11	1612	.34		1.60
300	.137	16.4	19	1492	.54		
400	.193	23.3	29	1380	.75		1.28
500	.255	30.8	39	1280	.97		
600	.325	39.3	53	1194	1.21	215	1.04
700	.401	48.5	1–09	1126	1.46	122	
800	.485	58.8	1–26	1072	1.74	83	0.89
900	.577	1–10.5	1–45	1026	2.03	66	
1000	.677	1–22.1	2–05	988	2.33	54	0.79
1100	.785	1–34.7	2–28	954	2.64	47	
1200	.901	1–48.1	2–51	925	2.96	40	
1300	1.024	2–03.7	3–17	895	3.29	34	
1400	1.154	2–19.4	3–45	868	3.63	30	
1500	1.292	2–36.0	4–14	843	3.98	27	0.63
1600	1.437	2–53.3	4–46	819	4.35	24	
1700	1.589	3–11.5	5–21	797	4.71	21	
1800	1.748	3–30.9	5–57	776	5.10		
1900	1.915	3–51.0	6–34	755	5.49		
2000	2.090	4–12.3	7–14	735	5.90		0.52
2100	2.274	4–34.1	7–56	716	6.32		
2200	2.468	4–57.8	8–42	698	6.74		
2300	2.673	5–22.2	9–32	680	7.18	Dangerous space is given for further end of range only.	
2400	2.888	5–47.7	10–26	662	7.63		
2500	3.113	6–14.4	11–23	646	8.10		
2600	3.349	6–42.4	12–25	630	8.57		
2700	3.596	7–11.7	13–32	614	9.06		
2800	3.854	7–42.4	14–45	599	9.57		
2900	4.124	8–14.7	16–05	587	10.09		
3000	4.406	8–48.4	17–32	575	10.62		0.37

Range Table for Driggs-Schroeder 3-pdr. Gun.

Diameter of Projectile....................1″.84
Weight " " ....3.25 lbs.
Length " " ....3.5 cals.
Radius " Ogival ....2.1 cals,

Initial Velocity (Black Powder).........2050 f. s.
Permanent Angle of Sight Bar .... 2°
Sight Radius..........................30″.19
Angle of Jump..............................0°

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Remaining Velocity.	Time of Flight.	Dangerous Space for Objects 6 Feet High.	Perforation of Steel.
Yards.	Ins.	° ′	F. S.	Secs.	Yards.	Ins.
0	—	—	—	—		3.86
100	0.035	04.0	1967	.15	All the range.	
200	.073	08.3	1887	.31		3.43
300	.113	12.6	1810	.47		
400	.155	17.7	1736	.64		3.04
500	.200			.82		
600	.247	28.2	1598	1.00		2.70
700	.297			1.19		
800	.350	39.9	1470	1.39	185	2.40
900	.407			1.60	136	
1000	.467	53.1	1353	1.81	111	2.13
1100	.529			2.04	90	
1200	.596	1–08.0	1251	2.28	75	
1300	.668			2.52	64	
1400	.744	1–24.7	1166	2.77	56	
1500	.823			3.03	50	1.64
1600	.907	1–43.3	1100	3.30	45	
1700	.996			3.58	40	
1800	1.089	2–03.9	1047	3.87	36	
1900	1.180			4.16	32	
2000	1.287	2–26.4	1003	4.45	28	1.39
2100	1.392			4.75	25	
2200	1.503	2–50.9	966	5.06	22	
2300	1.616			5.38		
2400	1.734	3–17.4	932	5.70		
2500	1.857			6.03		
2600	1.984	3–45.7	900	6.36		
2700	2.115			6.70		
2800	2.251		871	7.04		
2900	2.391			7.39		
3000	2.536	4–48.0	843	7.75		1.08
3100	2.685			8.11		
3200	2.839			8.48		
3300	2.997			8.86	Dangerous space is given for further end of range only.	
3400	3.160	5–58.5	793	9.24		
3500	3.328			9.63		
3600	3.501			10.03		
3700	3.680			10.43		
3800	3.864	7–17.6	748	10.84		
3900	4.054			11.26		
4000	4.249			11.68		0.87
4100	4.450			12.11		
4200	4.657	8–46.1	705	12.55		
4300	4.869			13.00		
4400	5.087			13.45		

Range Table for Driggs-Schroeder 6-pdr. Gun, (Mark II.)

Diameter of Projectile.... ....2′′.244
Weight " " ....6 lbs.
Length " " ....3¾ cals.
Radius " " ....2½ "

Initial Velocity (Black Powder).......................1914 f. s.
Permanent Angle of Sight Bar..................................2°
Sight Radius...35′′.111
Angle of Jump...0°

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Angle of Fall.	Remaining Velocity.	Time of Flight.	Dangerous Space for Objects 6 Feet High.	Perforation of Steel.
Yards.	Ins.	° ′	° ′	F. S.	Secs.	Yards.	Ins.
0	—	—	—	—	—	—	4.40
100	0.045	0–04.4	0–05	1854	0.16	All the range.	4.21
200	.095	09.4	10	1796	0.32		4.02
300	.148	14.5	15	1739	0.49		3.84
400	.203	19.8	21	1684	0.67		3.67
500	.259	25.3	28	1631	0.85		3.51
600	.317	31.0	35	1579	1.04		3.35
700	.378	37.0	43	1529	1 23	265	
800	.443	43.3	51	1480	1.43	191	3.05
900	.510	49.9	1–00	1434	1.63	140	
1000	.580	56.7	1–10	1389	1.85	110	2.79
1100	.653	1–03.9	1–21	1346	2.07	89	
1200	.730	1–11.4	1–33	1305	2.30	75	
1300	.811	1–19.3	1–45	1266	2.53	65	
1400	.895	1–27.5	1–58	1229	2 77	57	
1500	.982	1–36.1	2–12	1196	3.02	52	2.24
1600	1.073	1–45.0	2–27	1166	3.27	47	
1700	1.170	1–54.4	2–42	1140	3.53	42	
1800	1.272	2–04.4	2–58	1115	3.80	38	
1900	1.376	2–14.6	3–15	1092	4.07	34	
2000	1.483	2–25.0	3–33	1071	4.35	30	1.86
2100	1.594	2–35.7	3–52	1052	4.63	26	
2200	1.709	2–47.0	4–12	1035	4.82	23	
2300	1.828	2–58.7	4–32	1018	5.21		
2400	1.950	3–10.6	4–53	1002	5.51		
2500	2.075	3–22.8	5–14	987	5.81		1.71
2600	2 207	3–35.6	5–36	973	6.11		
2700	2.345	3–49.1	5–58	960	6.42		
2800	2.485	4–02.8	6–21	947	6.74		
2900	2.628	4–16.7	6–45	935	7.06		
3000	2.775	4–31.0	7–10	923	7.38		1.55
3100	2 925	4–45.7	7–36	912	7.71		
3200	3.080	5–00.7	8–02	901	8.04		
3300	3.241	5–16.2	8–28	890	8.38	Dangerous space is given for further end of range only.	
3400	3.407	5–32.3	8–56	879	8.72		
3500	3.575	5–48.6	9–24	869	9.07		1.43
3600	3.745	6–05.1	9–53	859	9.42		
3700	3.920	6–22.0	10–23	849	9.78		
3800	4.100	6–39.4	10–54	840	10.14		
3900	4.286	6–57.3	11–25	831	10.50		
4000	4.476	7–15.6	11–57	822	10.87		1.32
4100	4.671	7–34.4	12–30	814	11.24		
4200	4.869	7–53.4	13–04	806	11.62		
4300	5.073	8–13.0	13–38	798	12.00		
4400	5.283	8–33.1	14–14	790	12.38		
4500	5.499	8–53.7	14–50	783	12.77		1.23
4600	5.719	9–14 8	15–27	776	13.16		
4700	5.945	9–36.3	16–05	769	13.56		
4800	6.178	9–58.4	16–44	762	13.97		
4900	6.416	10–21.0	17–25	755	14.38		
5000	6.660	10–44.1	18–06	748	14,79		1.15
5100	6.910	11–07.7	18–48	741	15.20		
5200	7.168	11–31.9	19–31	735	15.60		
5300	7.432	11–56.7	20–15	729	16.05		
5400	7.704	12–22.1	21–00	723	16.48		
5500	7.984	12–48.2	21–46	718	16.92		1.08

Range Table for Driggs-Schroeder 12-pdr. Landing Gun.

Diameter of Projectile....................2″.75
Weight " " ....12 lbs.
Length " " ....3.91 cals.
Radius " Ogival....................1.5 "
Initial Velocity (Black Powder).........1300 f. s.
Permanent Angle of Sight Bar ....2°
Sight Radius ....36″.328
Angle of Jump..............................0°

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Angle of Fall.	Remaining Velocity.	Time of Flight.	Dangerous Space for Objects 6 Feet High.	Perforation of Steel.
Yards.	Ins.	° ′	° ′	F. S.	Secs.	Yards.	Ins.
100	0.105	0–09.9	0–10	1269	0.23	All the range.	2.72
200	.214	20.2	21	1240	.47		
300	.326	30.8	32	1212	.72		
400	.441	41.7	44	1186	.97		
500	.560	53.0	57	1163	1.22		2.40
600	.683	1–04.7	1–11	1141	1.48	130	
700	.810	1–16.7	1–25	1121	1.75	95	
800	.941	1–29.0	1–39	1102	2.02	76	
900	1.075	1–41.6	1–54	1085	2.29	65	
1000	1.211	1–54.5	2–10	1065	2.57	55	2.12
1100	1.351	2–07.7	2–27	1053	2.86	47	
1200	1.494	2–21.2	2–44	1038	3.14	42	
1300	1.640	2–35.0	3–01	1024	3.43	37	
1400	1.790	2–49.1	3–19	1011	3.73	34	
1500	1.942	3–03.5	3–38	999	4.03	31	1.93
1600	2.098	3–18.2	3–57	987	4.33	29	
1700	2.258	3–33.3	4–17	976	4.64	27	
1800	2.422	3–48.7	4–31	965	4.94	25	
1900	2.588	4–04·3	4–57	954	5.27	24	
2000	2.757	4–20.2	5–19	944	5.57		1.78
2100	2.929	4–36.4	5–41	934	5.89		
2200	3.105	4–52.9	6–03	924	6.21		
2300	3.285	5–09.8	6–26	915	6.54		
2400	3.468	5–27.0	6–50	906	6.87		
2500	3.654	5–44.4	7–14	897	7.20		1.66
2600	3.843	6–02.1	7–39	888	7.54		
2700	4.037	6–20.2	8–04	879	7.88		
2800	4.235	6–38.7	8–30	871	8.23		
2900	4.437	6–57.5	8–57	863	8.58		
3000	4.642	7–16.6	9–24	855	8.93		1.55
3100	4.851	7–36.1	9–52	847	9.28	Dangerous space is given for further end of range only.	
3200	5.064	7–55.9	10–21	839	9.64		
3300	5.282	8–16.1	10–51	832	10.00		
3400	5.505	8–36.7	11–21	825	10.36		
3500	5.733	8–57.7	11–51	818	10.73		1-45
3600	5.964	9–19.0	12–23	811	11.10		
3700	6.199	9–40.7	12–55	805	11.48		
3800	6.441	10–02.9	13–28	798	11.86		
3900	6.689	10–25.6	14–02	792	12.24		
4000	6.942	10–48.7	14–36	786	12.63		1.33
4100	7.201	11–12.3	15–12	780	13.02		
4200	7.465	11–36.3	15–48	774	13.41		
4300	7.736	12–00.9	16–25	769	13.81		
4400	8.014	12–26.0	17–02	764	14.21		

Range Table for Driggs-Schroeder 4-inch Gun.

Diameter of Projectile....................3″.96
Weight " " ....33 lbs.
Length " " ....3.1 cals.
Radius " Ogival.......................2 "

Initial Velocity (Black Powder).........2000 f. s.
Permanent Angle of Sight Bar............2° 45″
Sight Radius...........................84″.23
Angle of Jump ....0°

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Angle of Fall.	Remaining Velocity.	Time of Flight.	Perforation of Steel.
Yards.	Ins.	° ′	° ′	F. S.	Secs.	Ins.
0	—	—	—	—	—	7.26
100	0.103	04.2	04	1962	0.15	
200	.210	08.5	08	1925	.30	
300	.319	12.7	13	1888	.46	
400	.430	17.5	18	1853	.62	
500	.543	22.1	23	1817	.78	6.33
600	.659	26.9	29	1783	.95	
700	.779	31.8	34	1749	1.12	
800	.903	36.7	40	1716	1.30	
900	1.030	42.0	47	1684	1.47	
1000	1.161	47.2	53	1652	1.66	5.53
1100	1.295	52.7	1–00	1620	1.84	
1200	1.432	58.3	1–08	1590	2.02	
1300	1.573	1–04.9	1–15	1558	2.22	
1400	1.718	1–10.0	1–23	1530	2.41	
1500	1.866	1–16.0	1–32	1501	2.60	4.82
1600	2.018	1–22.2	1–40	1471	2.80	
1700	2.174	1–28.6	1–50	1444	3.01	
1800	2.335	1–35.2	1–59	1417	3.22	
1900	2.500	1–41.9	2–09	1390	3.44	
2000	2.670	1–48.9	2–20	1364	3.66	4.20
2100	2.845	1–56.0	2–31	1338	3.88	
2200	3.026	2–03.3	2–43	1314	4.11	
2300	3.212	2–10.8	2–55	1290	4.34	
2400	3.402	2–18.6	3–07	1268	4.57	
2500	3.597	2–26.5	3–21	1246	4.81	3.69
2600	3.797	2–34 7	3–35	1224	5.05	
2700	4.002	2–43.1	3–49	1205	5.30	
2800	4.213	2–51.7	4–03	1187	5.55	
2900	4.431	3–00.5	4–18	1170	5.81	
3000	4.656	3–09.6	4–34	1154	6.07	3.31
3100	4.886	3–18.9	4–50	1138	6.33	
3200	5.121	3–28.5	5–07	1123	6.60	
3300	5.362	3–38.0	5–24	1109	6.87	
3400	5.607	3–48.2	5–42	1096	7.15	
3500	5.858	3–58.4	5–59	1083	7.43	3.02
3600	6.115	4–08.9	6–18	1071	7.71	

Range Table for Driggs-Schroeder 4-inch Gun—Continued.

Range.	Height of Sight Bar Marks.	Angle of Elevation.	Angle of Fall.	Remaining Velocity.	Time of Flight.	Perforation of Steel.
Yards.	Ins.	° ′	° ′	F. S.	Secs.	Ins.
3700	6.379	4–19.7	6–37	1060	8.02	
3800	6.650	4–30.7	6–56	1049	8.28	
3900	6.928	4–41.8	7–16	1039	8.57	
4000	7.212	4–53.3	7–36	1029	8.87	2.81
4100	7.503	5–04.9	7–56	1020	9.16	
4200	7.800	5–16.9	8–17	1011	9.46	
4300	8.103	5–28.9	8–39	1002	9.77	
4400	8.413	5–42.1	9–00	994	10.08	
4500	8.730	5–55.3	9–22	986	10.39	
4600	9.053	6–07.7	9–45	978	10.71	
4700	9.382	6–20.1	10–08	970	11.02	
4800	9.716	6–33.2	10–31	963	11.34	
4900	10.056	6–46.9	10–55	956	11.67	
5000	10.402	7–00.7	11–19	949	12.00	2.50
5100	10.754	7–14.7	11–43	942	12.32	
5200	11.112	7–29.7	12–08	936	12.65	
5300	11.476	7–43.2	12–34	930	12.99	
5400	11.846	7–58.4	12–59	924	13.33	
5500	12.222	8–13.7	13–25	918	13.67	
5600	12.604	8–29.5	13–52	912	14.02	
5700	12.992	8–44.7	14–18	906	14.37	
5800	13.386	9–00.6	14–46	900	14.73	
5900	13.787	9–16.7	15–14	894	15.09	
6000	14.196	9–33.2	15–42	888	15.45	2.27
6100	14.613	9–49.8	16–11	883	15.81	
6200	15.039	10–06.9	16–40	878	16.18	
6300	15.474	10–24.2	17–09	873	16.55	
6400	15.918	10–41.7	17–39	868	16.92	
6500	16.371	10–59.0	18–10	864	17.31	
6600	16.834	11–17.8	18–41	859	17.70	
6700	17.308	11–36.3	19–13	855	18.09	
6800	17.792	11–55.2	19–45	851	18.48	
6900	18 287	12–14.2	20–17	847	18.88	
7000	18.792	12–33.9	20–40	843	19.28	2.11
7100	19.308	12–53.6	21–24	839	19.68	
7200	19.835	13–14.0	21–58	835	20.10	
7300	20.372	13–34.4	22–32	832	20.51	
7400	20.919	13–55.5	23–07	829	20.94	
7500	21.477	14–16.7	23–43	826	21.36	
7600	22.046	14–38.7	24–29	823	21.80	
7700	22.625	15–00.8	24–56	820	22.24	

Guns.

	Unit.	1-Pounder.			3-Pounder.	6-Pounder.				9-Pounder.	12-Pounder (Field).	14-Pounder.	3.2-inch (Field).	4-inch.	5-inch.	6-inch.
		L. P.	H. P. Mark I.	H. P. Mark II.		Field.	H. P. Mark I.	H. P. Mark II.	H. P. Mark III.							
Caliber	In.	1.457	1.457	1.457	1.85	2.244	2.244	2.244	2.244	2.56	2.76	2.953	3.2	4	5	6
Diameter at bottom of chamber	"	1.575	1.61	1.61	2.283	2.709	2.709	2.709	2.709	3.15	2.90	3.96	3.8	4.44	5.55	6.66
External diameter round chamber	"	3.8	3.8	3.8	6.61	7.5	8.3	8.3	8.3	9	6.15	11.95	9 25	13	16.5	20
Total length	"	50.9	61.08	75.986	87.95	72	107.33	118.55	107.33	121.35	74.5	139.98	87.7	166.5	207.75	249
Length of bore	"	48.1	58.28	72.85	83.25	67.32	100.98	112.2	100.98	115.2	69	132.89	80.6	160	200	240
" "	Cal.	33	40	50	45	30	45	50	45	45	25	45	25.2	40	40	40
Travel of shell	"	30.7	36.7	46.7	37.7	26.7	40.4	45.4	38	37.2	21.3	38	23.7	33.6	33.6	34.2
Number of grooves	......	12	12	12	20	24	24	24	24	24	24	24	24	30	30	24
Depth " "	In.	.0155	.0155	.0155	.016	.012	.012	.012	.012	.015	.015	.015	.04	.025	.025	.05
Width " "	"	.322	.322	.322	.23	.2205	.2205	.2205	.2205	.26	.26	.3	.3	.279	.349	.485 to .415
Sight radius	"	26.4	26.4	28 436	30.19	23.6	35.11	35.11	38.56	45	36.33	52	31.05	82.23	......	......
Line of sight from axis of gun. Hor. dist.	"	1.7	1.7	1.63	2.36	2.6	2.65	2.65	2.65	......		......	4.125	5	......	......
Line of sight from axis of gun. Vert. dist.	"	2.5	2.5	2	4.1	3.8	4.74	4.74	4.74	......		......	4.6	6	......	......

Guns.

	Unit.	1-Pounder.			3-Pounder.	6-Pounder.				9-Pounder.	12-Pounder (Field).	14-Pounder.	3.2-inch (Field).*	4-inch.	5-inch.	6-inch.
		L. P.	H. P. Mark I.	H. P. Mark II.		Field.	H. P. Mark I.	H. P. Mark II.	H. P. Mark III.							
Center of gravity from face of breech..................	In.	16.76	21.48	25.2	26.8	22.5	30.45	37.1	33.9	38.9	24.34	42.6	28.9	58	72.1	86.5
Diameter of trunnions........	"	1.77	1.77	......	2.75	3.0	3.35	.....	......	......	......	......	3.8	....	......	......
Weight of breech-mechanism†	Lbs.	4.5	4.5	4.5	15	20	28	28	28	......	28	......	34	74	90	120
" " Gun complete.....	"	88	100	122	500	400	783	791	910	1300	350	2140	794	3613	7280	12000
" " Powder charge.....	"	.17	.31	.31	1.72	1.2	1.87	1.87	3	4.4	2	7.5	......	10 to 12	28 to 30	44 to 47
Volume of chamber...........	Cu. In.	5.48	8.53	8.53	48.53	39.8	54.45	54.45	84.3	130	51.4	210	50	362.7	713	1126
Ratio of gun-weight to cube of caliber................	... ..	28.4	32.3	39.4	79	35.4	69.3	70	80.5	77.5	16.64	83.1	24.2	56.5	58.1	55.5
Ratio of gun-weight to projectile	......	80	90.9	110.9	153.4	64.5	130.5	131.8	151.7	147.7	29.16	153	48.1	109.5	145.6	120
Ratio of projectile weight to charge..................	......	6.1	3.55	3.55	1.90	5	3.21	3.21	2	2	6	1.87	......	......	1.66	2.13
Muzzle velocity...............	F. S.	1460	1800	1884	2050	1500	1870	1914	2200	2210	1300	2250	1450	2000	2250	2150
" energy	F. T.	16.3	24.7	27.1	95	93.6	145.4	152.4	201.3	297.9	140	491.3	240.5	915	1755	3204
Energy per inch of circum. of shell	"	3.6	5.5	6.0	16.4	13.3	20.7	21.7	28.6	37.2	16.2	53.2	24	73.2	105.7	170.9
Energy per sq. inch of section of shell	"	10.0	15.2	16.7	35.7	23.8	36-9	38.7	51.1	58.5	23.7	72.5	30	73.5	90.1	114.6
Energy per ton of gun........	"	415	554	502	426	526	415	431.7	496	511	897	514	679	568	540	598

*The ballistical data of the 3.2-inch gun is with smokeless powder.

† The weight of breech mechanism includes all lifting parts.

Ammunition.

		Unit.	1-Pounder.		3-Pounder.	6-Pounder.			9-Pounder.	12-Pounder (Field).	14-Pounder.	3.2-inch (Field).	4-inch.	5-inch.	6-inch.
			L. P.	H. P. Marks I. & II.		Field.	H. P. Marks I. & II.	H. P. Mark III.							
A. P. Shell.	Radius of ogival	Cal.	2.25	2.25	2.1	......	2.46	2.46	2.5	......	2.5	......	2	2	2
	Total length	In.	3.66	3.66	6.46	......	8.42	8.42	8.91	......	10.28	......	12.18	12.34	17.28
	Weight of shell	Lbs.	.94	.94	3.03	......	5.61	5.61	8.39	......	13.54	......	33	50	100
	" " burster	"	.03	.03	.10	......	.26	.26	.27	......	.33	......	......	......	......
	" " fuze	"	.13	.13	.13	......	.13	.13	.13	......	.13	.....	......	......	......
	" total	"	1.10	1.10	3.26	......	6	6	8.79	......	14	......	33	50	100
	Ratio of weight to cube of caliber	......	.356	.356	.515	.531	.531	.531	.525	......	.544	.416	.516	.40	.46
Common Shell.	Radius of ogival	Cal.	2.25	2.25	2.29	2.46	2.46	2.46	2.5	1.5	2.5	2	2	2	2
	Total length	In.	3.66	3.66	6.89	8.42	8.42	8.42	9.72	10.75	11.46	11.43	13.8	14.89	21.76
	Weight of shell	Lbs.	.93	.93	2.99	5.61	5.61	5.61	8.28	10.93	13.28	15.87	32*	48*	91
	" " burster	"	.04	.04	.14	.26	.26	.26	.38	.81	.60	.50	1±	2±	8±
	" " fuze	"	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
	" total	"	1.10	1.10	3.26	6	6	6	8.79	11.87	14.01	16.5	33	50	99
Fixed Ammunition.	Total length, (A. P. shell)	In.	6.57	8.22	20.11	......	19.02	......	......	.....	......	......	44.77	44.78	......
	" " (common shell)	"	6.57	8.22	20.55	16.19	19.02	......	......	18.73	.....	18.33	46.47	47.33	......
	Weight of empty case	Lbs.	.25	.37	1.81	1.84	2.09	......	......	2.06	......	......	12	18	30.75
	" " charge	"	.17	.31	1.72	1.2	1.87	3	4.4	2	7.5	......	10 to 12	28 to 30	44 to 47
	" " Felt wad	Oz.	.11	.11	.21	.25	.25	.25	.25	.25	......	.....	.50	.50	Case and projectile separate.
	Total weight, (A. P. shell)	Lbs.	1.53	1.79	6.80	......	9.97	......	......	.....	......	......	......	......	
	" " (common shell)	"	1.53	1.79	6.80	9.05	9.97	......	.....	15.91	......	......	......	......	

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*The 4 and 5 inch common shell are semi-armor piercing forged steel.

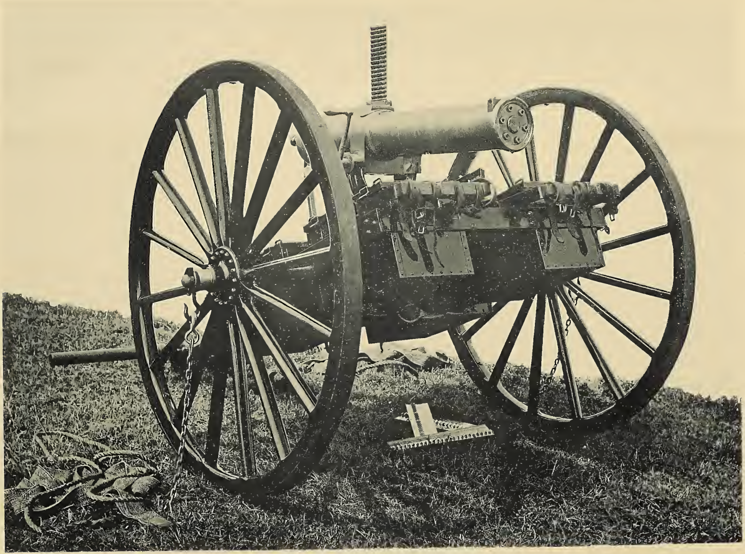
The Accles Machine Gun.

The Accles Machine Gun is the only one of five competitors which was able to conclude the programme of an official competitive trial before the U. S. Navy Department, in December, 1895.

In addition to the superior endurance shown in that trial, this weapon possesses the following unique features. The shaft of the lever which actuates the gun is at the center of gravity, and all vibration tending to destroy accuracy of fire in rapid working is avoided. By a simple clutch at the side, the firing mechanism can be put in or out of gear instantaneously, and consequently the gunner can either throw a continuous stream of bullets, or fire shot by shot, the handle being turned steadily all the time. By means of a safety cam, the cocking device may be moved back out of action, so that the firing-pin will not touch it while the gun is being operated; this safety cam is put in and out of action by a key; in this way the undue snapping of firing-pins is prevented while the gun is being worked for drill or explanation; in case of capture, also, if set at "safe" the gun cannot be used by the enemy until the breech-plate has been unscrewed and the cam turned.

The gun is mounted, as desired, on a Field Carriage, Parapet, Embrasure, or Naval Mount. It is arranged to be actuated both by hand and by electricity, the main current from the ship's dynamo or shore plant being led to a small motor which is connected with the operating shaft.

PLATE XVIII.



ACCLES MACHINE GUN, EQUIPPED FOR THE MARCH.

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